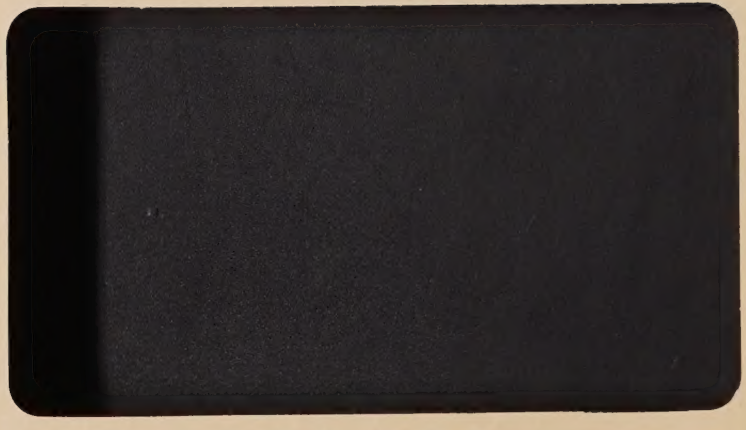
INSTRUCTION MANUAL

Type 1168
Coherent Decade Frequency Synthesizer

A

GENERAL RADIO



for factory ...
8-617-369-4400
GAR

Contents

SPECIFICATIONS
INTRODUCTION – SECTION 1
INSTALLATION – SECTION 2
OPERATION – SECTION 3
THEORY – SECTION 4
SERVICE AND MAINTENANCE – SECTION 5
PARTS LISTS AND DIAGRAMS – SECTION 6

WARRANTY

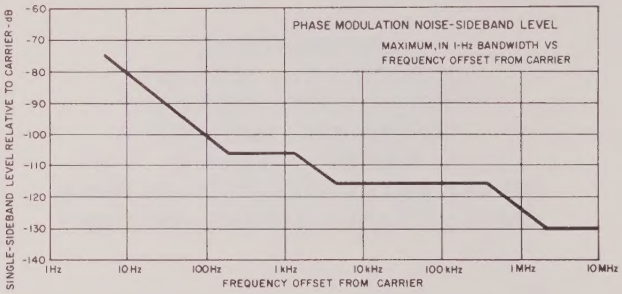
We warrant that each new instrument manufactured and sold by us is free from defects in material and workmanship and that, properly used, it will perform in full accordance with applicable specifications for a period of two years after original shipment. Any instrument or component that is found within the two-year period not to meet these standards after examination by our factory, District Office, or authorized repair agency personnel will be repaired or, at our option, replaced without charge, except for tubes or batteries that have given normal service.

Type 1168
Coherent Decade Frequency Synthesizer

A

©GENERAL RADIO COMPANY 1971
Concord, Massachusetts, U.S.A. 01742
Form 1168-0100-A
July 1971
ID-0100

Specifications



Frequency: 10 kHz to 159.999999 MHz. Controlled by one 2-position and eight 10-position in-line readout dials or by external binary and 8-4-2-1 BCD signals (two most-significant digits use all 16 combinations of binary, remaining digits are BCD). Logic 1 must be 0 to +0.5 V at 3 mA; logic 0 must be allowed to rise to +5 V (internal pullup ≈ 2 kΩ). Signals are applied to rear-panel Amphenol Type 57 connector. Manual or remote control is selected by a single panel control operated by a screwdriver or coin. ***Programming time:*** < 200 μs for steps ⩾ 100 kHz, < 5 ms for steps of 10 and 1 kHz, < 50 ms for steps ⩽ 100 Hz.

Accuracy: Equal to that of drive source. Drive source is internal, external lock, or external drive for master version; external drive only for slave version. ***Internal oscillator*** is 10-MHz precision oscillator in proportional-control oven; ***adjustment range***, ±2 X 10^{-6} at rear-panel control; ***stability***, < 2 X 10^{-10}/°C from 0 to 50 °C when operated continuously; ***drift***, ±1 X 10^{-8}/wk, ≈ 1 X 10^{-9}/day after one month of continuous operation; ***with 10% line-voltage variation***, < 2 X 10^{-10}; ***restabilizes*** to within ≈ 1 X 10^{-8} two hours after power interruption.

Master-Version External Lock: Internal oscillator can be locked to external signal of 5 MHz (or integer sub-multiple down to 100 kHz), 0.1 V rms min into 1 kΩ, 3 V max into 50 Ω, applied to rear-panel BNC connector. After power interruption, 25 m warmup required for oscillator to stabilize within lock range.

Master-Version External Drive: A switch permits choice of internal drive or external drive at 10 MHz, 0.5 ± 0.05 V rms into 50 Ω, applied to rear-panel BNC connector.

Slave-Version External Drive: Slave version requires external drive of 5 MHz or 10 MHz, 0.13 V min to 3 V max into 50 Ω, applied to rear-panel BNC connector. Drive can be supplied by master-version 10-MHz output or by another slave version.

Output: 0.1 to 1 V into 50 Ω, 50-Ω source, available at GR874® recessed locking connector that can be mounted on front or rear panel. Level set by calibrated panel control or by an external dc control signal equal to +4 X desired output voltage (rms) into 100 kΩ. ***Programming time***, < 10 ms to within 1 dB. ***Accuracy of control***, ±2 dB including leveling errors. (See table below.)

Phase Modulation: Output can be phase modulated ± 3 radians from dc to 300 kHz, ± 1 radian at 1-MHz modulation frequency, by external signal of 1 V/radian at dc, flat within 2 dB to 300 kHz, into 7.5 kΩ applied to rear-panel BNC connector.

Auxiliary Outputs: 10 MHz at 0.5 V rms into 50 Ω and 1 MHz at ⩾ 2 V pk-pk into 10 kΩ available at rear-panel BNC connectors.

Supplied: Power cord, 874-R22LA Patch Cord for output.

Available: GR874 adaptors, 1452 Programmable Attenuator.

Power: 100 to 125 or 200 to 250 V, 50 to 60 Hz, 55 W.

Mechanical: Rack or bench mount. ***Dimensions*** (w x h x d): Bench, 19.75X5.15X22.88 in. (502X131X581 mm); rack, 19X3.5X20.38 in. (483X89X517 mm). WEIGHT: Bench, 48 lb (22 kg) net, 58 lb (26 kg) shipping; rack 41 lb (18 kg) net, 49 lb (23 kg) shipping.

Catalog Number	Description
	1168 Frequency Synthesizer, master
1168-9720	Bench
1168-9721	Rack
	1168 Frequency Synthesizer, slave
1168-9722	Bench
1168-9723	Rack

	10 kHz	100 kHz	1 MHz	10 MHz	110 MHz	150 MHz	160 MHz
Fractional Frequency Deviation, rms							
10-ms averaging time		5 X 10^{-7}	5 X 10^{-8}	5 X 10^{-9}		7 X 10^{-10}	
1-s averaging time		5 X 10^{-9}	5 X 10^{-10}	5 X 10^{-11}		3 X 10^{-11}	
Output Level, full output	−0, +1 dB	±0.3 dB					
1/10 output	−1, +2 dB	±1.3 dB (±1 dB typical)					
Harmonics, full output	< −25 dB	< −30 dB					
Discrete Non-Harmonics	< −60 dB (−70 dB typical)				< −55 dB (−60 dB typical)		
Noise Modulation phase, rms	< −53 dB, re 1 radian, 0.5 Hz to 15 kHz						
amplitude, rms	< −63 dB, re 100% carrier, 0.5 Hz to 15 kHz						

U.S. Patent No. 3,509,483

Introduction—Section 1

1.1 GENERAL 1-1
1.2 DESCRIPTION 1-1
1.3 CONTROLS, CONNECTORS, AND INDICATORS 1-1
1.4 SYSTEMS 1-4
1.5 ACCESSORIES SUPPLIED 1-4
1.6 ACCESSORIES AVAILABLE 1-6

1.1 GENERAL.

The Type 1168 Coherent Decade Frequency Synthesizer provides highly stable, accurate frequencies, manually adjustable or programmable from 10 kHz to 159.999999 MHz, in 1-Hz steps. Output frequency is derived from a single source by a series of arithmetic operations on frequency (addition, subtraction, multiplication and division) and employs phase-locked oscillators for digital frequency selection.

A variety of applications exist for the unit in advanced communications, spectrum analysis, physical, medical, and other areas of research. Applications information can be found in the GR reprint Form Number 3218-A, available upon request to General Radio Company.

1.2 DESCRIPTION.

1.2.1 Electrical.

Two versions of the instrument are available, master and slave. The master version contains a built-in precision quartz crystal oscillator, which can be phase-locked to an external frequency standard or replaced by an external source. The slave version must be driven by an external source, which can be the auxiliary 10-MHz output of a master version, another slave version,or any other precision 5- or 10- MHz source. Any number of slave versions can be cascaded if the first one is driven from a suitable external source.

Mode of operation can be either local or remote and is selected with a single front-panel control (10 Figure 1-1). With this control (FREQUENCY SELECT) set to LOCAL, direct decimal setting of the output frequency can be accomplished with the front-panel knobs; set to REMOTE, frequency selection is by a combination of external binary and 1-2-4-8 BCD signals. (The two most significant digits use all 16 combinations of binary, and the remaining digits are BCD.) Negative logic is used and the logic levels are 0 and +5 V nominal, and are compatible with standard DTL and TTL integrated logic circuits.

The output level, into an impedance of 50Ω is 0.1 to 1 V rms. A calibrated panel control is used to manually set the level, or it can be programmed with a dc voltage exactly four times the rms output.

Phase modulation at rates from dc to 300 kHz (see specifications) can be used to modulate the output of the synthesizer. The modulation signal is applied to a rear-panel BNC jack.

1.2.2 Mechanical.

All circuits are on plug-in etched-circuit boards, with the exception of the power supply and precision oscillator (or input-drive circuit for the slave version). The boards plug into a number of tightly shielded section enclosures whose covers are forced on or off by captive screws for quick accessibility. Most enclosures are internally divided and contain two related circuit boards. Board sockets are mounted on the enclosure base tray and are identified, on the opposite side of the base, with terminal numbers and function designations. Wiring between section enclosures is by semirigid coaxial cable for signal connections and feed-through capacitors are used to maintain rf isolation.

Large in-line numerals behind windows, in the compact uncluttered panel, indicate the manually-selected frequency.

The instrument is available in either a bench cabinet or an EIA standard RS-310, 19-in. relay rack. Mounting instructions are given in para. 2.2 and include converting from one model to the other. Check Figure 2-1 for complete dimensions.

1.3 CONTROLS, CONNECTORS, AND INDICATORS.

Figures 1-1, 1-2, and 1-3 show the front- and rear-panel controls, connectors, and indicators for both synthesizer versions. Tables 1-1, 1-2, and 1-3 identify all controls, connectors and indicators.

The controls, connectors, and indicator referenced with an asterisk in Tables 1-1 and 1-2 apply to the master version only. Figure 1-3 and Table 1-3 apply to the slave version only.

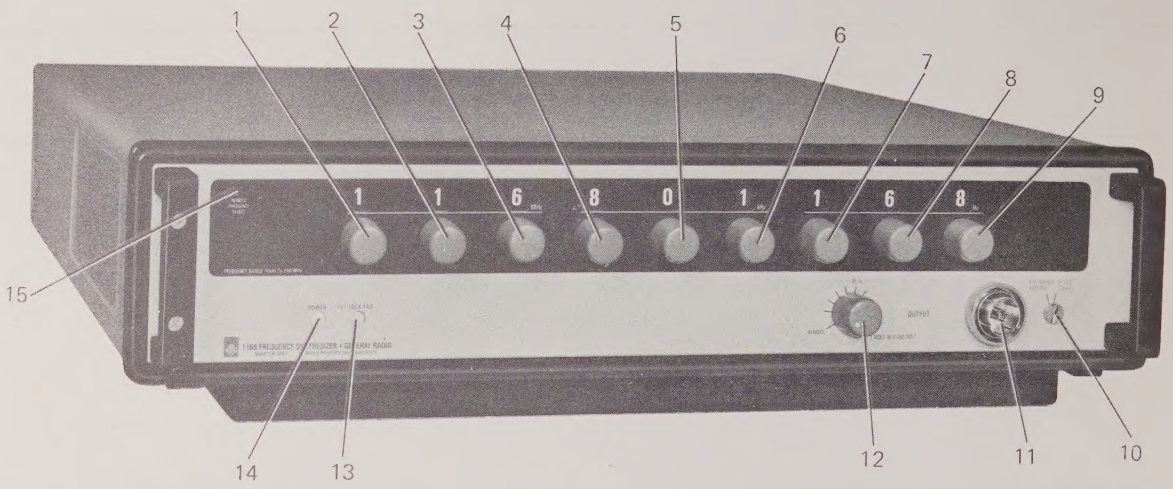


Figure 1-1. Front-panel controls, indicators and connector.

Table 1-1

FRONT-PANEL CONTROLS, INDICATORS AND CONNECTOR

Fig. 1-1 Ref.	Name	Description	Function	Remarks
1-9	Frequency Dial Assembly knobs	(1) is a two-position switch (2-9) are ten-position switches	Frequency control. In-line numerals indicate frequency.	Not effective when REMOTE FREQUENCY SELECT lamp is on.
10	FREQUENCY SELECT REMOTE/LOCAL	Two-position slotted control	Select local or remote frequency control.	In remote position, energizes remote frequency-select lamp.
11	OUTPUT connector	GR874®	Low-loss, quick-connect connector for output signal.	Can be mounted either on front or rear panel.
12	OUTPUT control	Calibrated rotary potentiometer, 0.1 to 1 V plus REMOTE position	Controls and indicates rf output voltage across 50 Ω.	REMOTE position transfers control to rear-panel LEVEL PROGRAM connector.
13*	EXT LOCK FAIL Indicator	Red light	Indicates phase-lock failure or lack of control signal.	Disabled if no patch cord is connected to external LOCK connector. Slave unit has POWER switch in place of indicator.
14	POWER Indicator	White light	Indicates instrument is on.	Master unit has no power switch. Turn-on is accomplished when line cord is connected.
15	REMOTE FREQUENCY SELECT	Red light	Indicates remote operation.	Lights when FREQUENCY SELECT control is set to REMOTE.

*Master version only.

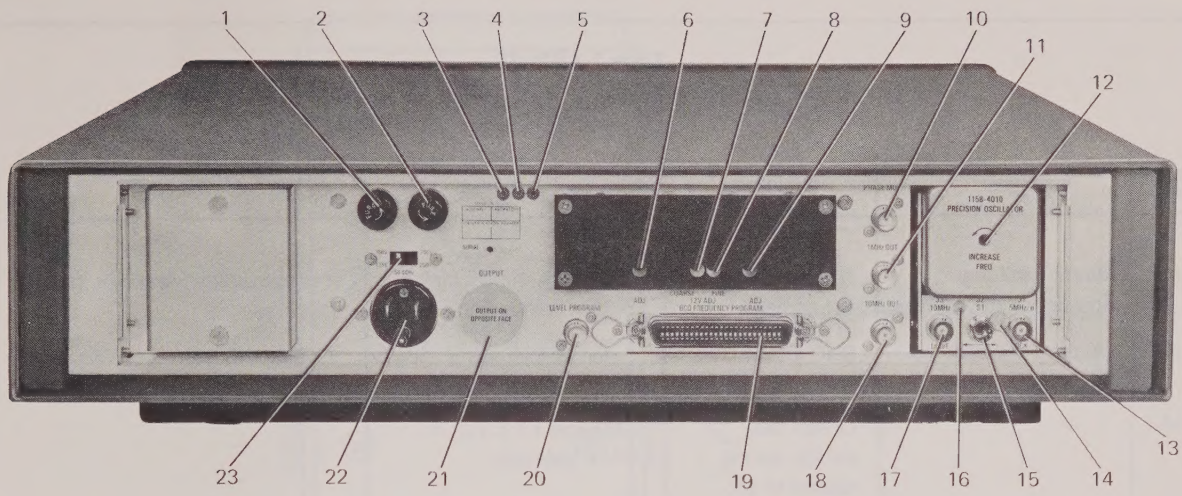


Figure 1-2. Rear-panel controls, indicators and connectors.

Table 1-2

REAR-PANEL CONTROLS AND CONNECTORS

Fig. 1-2 Ref.	Name	Description	Function	Remarks
1	Fuse	Extractor-post fuse holder	Contains 6/10A fuse for 110-V operation.	Bussman Manufacturing Company slo-blo
2	Fuse	Extractor-post fuse holder	Contains 3/10A fuse for 220-V operation.	Bussman Manufacturing Company slo-blo
3	+18 V	Pin jack	Power supply test point.	Accepts std. 0.80 test probe.
4	-12 V	Pin jack	Power supply test point.	
5	+5.6 V	Pin jack	Power supply test point.	
6	+18 V ADJ	Hole in metal cover	Access for 18-V adjustment.	FACTORY ADJUSTMENT Do not change unless absolutely necessary (refer to para. 5.6.2).
7	-12 V ADJ (COARSE)	Hole in metal cover	Access for -12 V COARSE adjustment.	
8	-12 V ADJ (FINE)	Hole in metal cover	Access for -12 V FINE adjustment.	
9	+5.6 V ADJ	Hole in metal cover	Access for +5.6 V adjustment.	
10	Phase Mod	BNC jack	External phase-modulation signal input.	±3 radians from dc to 300 kHz with 1 V/radian into 7.5 kΩ, ±1 radian at 1 MHz modulation frequency with ±3-V peak input.
11	1 MHz OUT	BNC jack	1-MHz reference-frequency output.	Derived from synthesizer driving signal.

Table 1-2 (Cont)

REAR-PANEL CONTROLS AND CONNECTORS

Fig. 1-2 Ref.	Name	Description	Function	Remarks
12*	Master oscillator Frequency Adjustment	Screwdriver adjustment	Adjust master-oscillator-output frequency.	Periodic adjustment may be required.
13*	J1, 5-MHz LOCK	BNC jack	External-lock-signal input.	Connecting patch cord activates EXT LOCK FAIL indicator.
14*	——	On-off tab switch, spring loaded to off position	Activates EXT LOCK FAIL indicator.	
15*	S1	Two-position toggle switch	Permits a choice of internal or external drive.	Turns off master oscillator when set to DRIVE position.
16*	J2	Pin connector 15 to 18 V at 0.2 A maximum	Keep-alive battery input.	
17*	J3 10 MHz DRIVE	BNC jack	External-drive-signal input.	Amplitude of signal must be 0.5 V ±.05 V rms.
18	10 MHz OUT	BNC jack	10-MHz reference output.	Derived from synthesizer driving signal.
19	BCD FREQUENCY PROGRAM	50-pin Amphenol Type 57	External BCD frequency-selection input.	Accepts Amphenol Type 57 plug.
20	LEVEL PROGRAM	BNC jack	External input for output level control.	0 to 4 V dc for 0 to 1-V output into 50 Ω.
21	——	Removable disk	Used to fill OUTPUT connector hole.	OUTPUT connector mounted on opposite panel.
22	——	3-wire plug	Accepts 3-wire ac-line cord to power instrument.	
23	50-60 Hz, 100 V – 125 V, 200 V – 250 V	Two-position slide switch	Switches line-power connection for either 110 V or 220 V ac.	100 V – 125 V 50-60 Hz 200 V – 250 V 105 V – 125 V 400 Hz 210 V – 250 V

* Master version only.

1.4 SYSTEMS.

Since additional equipment can expand the basic capabilities of most General Radio instruments, including our synthesizers, intra-company arrangements have been made to supply complete systems; inquiries are invited. Each system, custom tailored to individual requirements and including only the equipment necessary to perform the required task, is completely assembled and checked as a unit.

Such systems have wide application and can be used for laboratory development, production monitoring, final quality assurance, production-lot sorting, incoming inspection, environmental testing, reliability evaluation, etc., on an automatic or semi-automatic basis.

1.5 ACCESSORIES SUPPLIED.

Table 1-4 lists the accessories supplied with the 1168 Synthesizer.

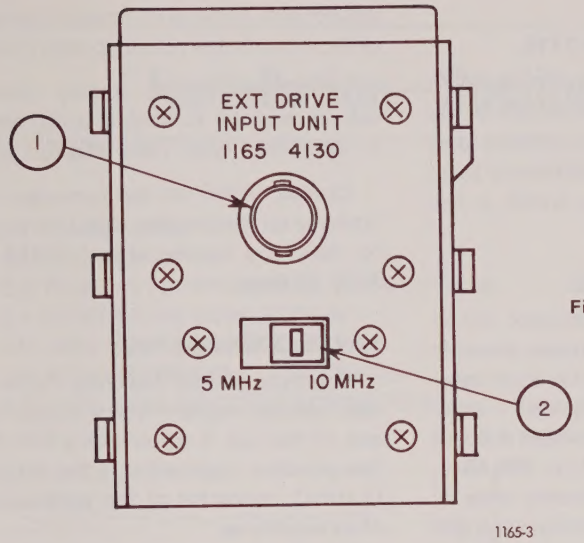


Figure 1-3. External drive input module.

Table 1-3

EDI MODULE CONTROL AND CONNECTOR

Fig. 1-3 Ref.	Name	Description	Function	Remarks
1	INPUT	BNC jack	External drive-signal input	The slave unit must be externally driven.
2	5 MHz 10 MHz	Two-position slide-switch	Switches external source connection for either 5 MHz or 10 MHz.	External source frequency must be either 5 MHz or 10 MHz.

Table 1-4

ACCESSORIES SUPPLIED

Name	Description	Part Number
Power Cord	7-feet, 3-wire	4200-9622
Coaxial Patch cord	3-feet, Type 874-R22LA	0874-9683
FREQ PROGRAM Connector	50-pin, Amphenol Type 57	Amphenol P/N 57-30500

1.6 ACCESSORIES AVAILABLE.

1.6.1 Standard Frequency Oscillator — Type 1115.

This standard meets the requirements for a stable laboratory standard of frequency for the calibration of the synthesizer output. Its oscillator uses a 5th-overtone, 5-MHz crystal in a single-stage, proportional-control oven, which maintains the crystal temperature within a few milli-degrees centigrade.

1.6.2 Programmable Attenuator — Type 1452.

The GR 1452 programmable coaxial attenuator can be used to attenuate the synthesizer output by known amounts in response to binary coded control signals (or front-panel switch settings). The resolution of the instrument — smallest calibrated step — is 1 dB; the total attenuation is 80 dB and the operating frequency range is 10 kHz to 500 MHz. The accuracy of the attenuator, over the frequency range of the synthesizer, is approximately 1% of setting + 0.4 dB.

1.6.3 Coaxial Adaptors.

As with similar General Radio equipment, the synthesizers use the quick-connect GR874 coaxial connector. However, for the user wishing to mate the instruments with components fitted with coaxial connectors of some other series, it is a simple matter to adapt to that series.

GR874 adaptors to leading commercial and military coaxial series (or to binding posts) are available to convert to the desired type. These adaptors are listed in Table 1-5.

Over-all VSWR of the converted GR874 connector is typically no greater than that of the other-series connector by itself, and leakage at the GR874 junction is typically >120 dB down.

1.6.4 75-Ω Matching Pad.

The Type 874-MP Matching Pad is a two port, minimum loss, resistive network with a typical loss of 5.72 dB. Each end of the pad is fitted with a GR874 locking connector. The principal application is the conversion of the GR874 OUTPUT connector of the synthesizer from a 50-Ω to a 75-Ω impedance.

The frequency range of the pad is dc to 1 GHz and it can be used to 8.5 GHz. The maximum power rating is 1 W continuous.

For more information on a complete line of coaxial adaptors, contact your nearest General Radio District Office.

Table 1-5
GR874 ADAPTORS

TO TYPE		TYPE 874†	GR PART NUMBER
APC-7		QAP7L	0874-9791
BNC	plug	QBJL	0874-9701
	jack	QBPAL	0874-9801
GR900®		Q900L	0874-9709
N	plug	QNJL	0874-9711
	jack	QNPL	0874-9811
SMA	plug	QMMJL	0874-9723
	jack	QMMPL	0874-9823

† Locking GR874 Connector.

Example: To connect Type 874 to a type-N jack, order Type 874-QNPL

Installation–Section 2

2.1 DIMENSIONS 2-1
2.2 MOUNTING 2-1
2.3 REMOTE PROGRAMMING CONNECTIONS 2-3
2.4 POWER-LINE CONNECTION 2-4
2.5 LINE-VOLTAGE REGULATION 2-4
2.6 ENVIRONMENTAL CONDITIONS 2-5
2.7 EXTERNAL BATTERY CONNECTOR 2-5

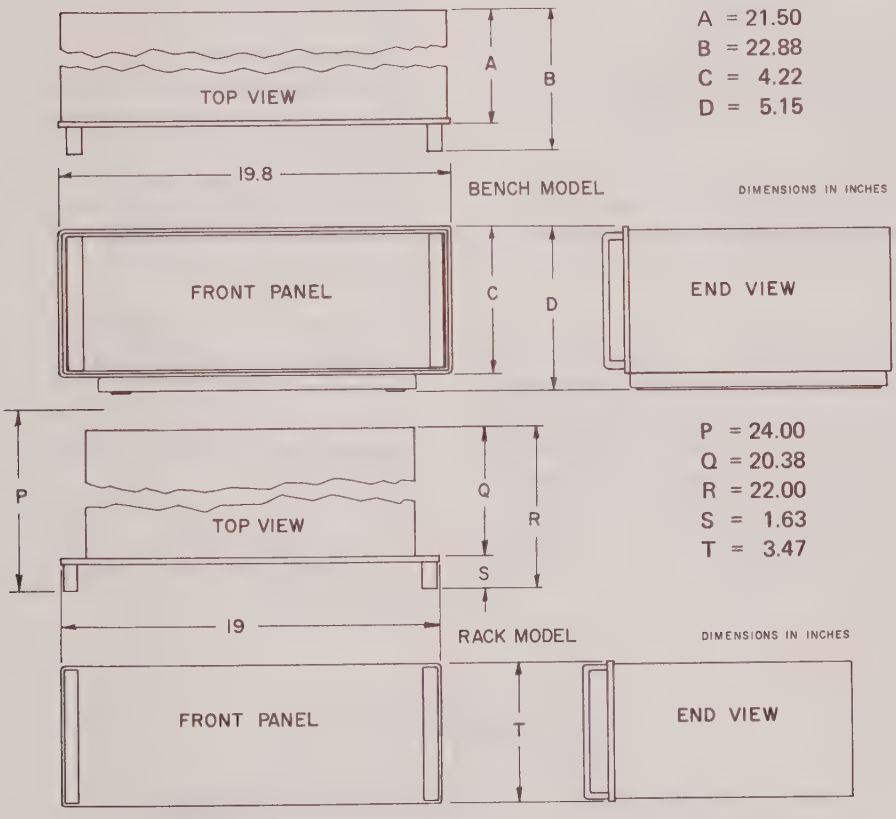


Figure 2-1. Dimensions of the Synthesizer (inches).

2.1 DIMENSIONS.

Dimensions of the rack and bench models are shown in Figure 2-1.

2.2 MOUNTING.

2.2.1 General.

The unit is available in two models, bench mount and relay-rack mount, either of which can be converted to the other by the installation of a simple conversion set.

2.2.2 Bench Mounting.

The bench-mount cabinet is made of formed and welded 1/8-in. aluminum finished in baked-on, medium gray crackle paint and has a tilt base. The instrument is retained in the case by four front-panel screws accessible through holes in the carrying handles. To remove the instrument from its case, remove the four front-panel screws and withdraw the instrument. Slide blocks on the instrument engage tracks in the case to guide insertion and withdrawal.

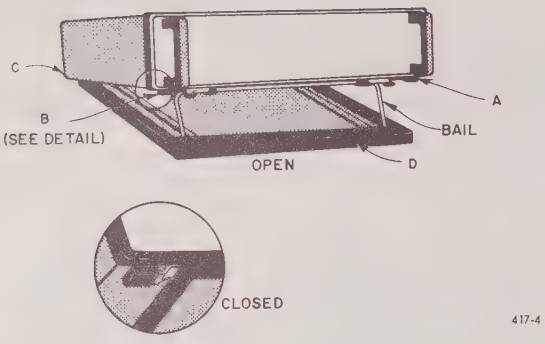


Figure 2-2. The bail can be used to tilt the instrument, providing a better view of the front-panel indicators.

To insert the instrument into the case, straddle the tracks with the rear guide blocks and push all the way into the case. Secure the four front-panel screws.

WARNING

When tilting the instrument or removing the tilt, do not allow your fingers to come between the cabinet and its base.

2.2.3 Tilting.

The bench models of the synthesizer are delivered completely assembled in a metal cabinet, ready for bench use. A convenient bail, located along the bottom front edge of the instrument, can be pulled down to raise the front and provide a better view of the front-panel indicators (see Figure 2-2). To tilt the instrument, proceed as follows:

a. Place the right thumb on the right-hand release toggle (A) and the left thumb on the left-hand release toggle (B) under the front corners of the instrument.

b. Push both release toggles toward the rear as far as they will go.

c. Using the rear of the base (C) as a pivot, lift the front of the instrument, permitting the bail to drop down on the base.

d. With one hand, hold the instrument in the tilted position; with the other, pull the bail forward as far as it will go and carefully lower the instrument. The bail is now locked in place and the instrument will remain in the tilted position.

Reverse this procedure to eliminate the tilt. Be sure the toggles are pushed back, toward the rear of the instrument. Then lower the front carefully onto the base. Lock the base to the bottom of the instrument by sliding the toggles (A and B) forward.

2.2.4 Cabinet Removal.

To remove a bench-model instrument from its cabinet:

Remove the four panel screws (A, Figure 2-3), P/N 7270-6310, two on each side of the front panel. These are No. 10-32, 9/16-in. screws, with nylon washers. To loosen them, insert a Phillips-head screwdriver through the holes in the handles, shown in the figure. Then pull the instrument forward, out of the cabinet.

2.2.5 Conversion to Rack Mounting.

The following procedure is used to convert a bench model to a rack-mounted model.

a. Order rack-cabinet assembly (P/N 4174-3997), a hardware set (P/N 4174-2000), and a rear cover (P/N 4171-1165).

b. Disconnect any external cables, remove the front-panel screws and withdraw the instrument from the case.

c. Install the rack-cabinet in the relay rack and insert the instrument.

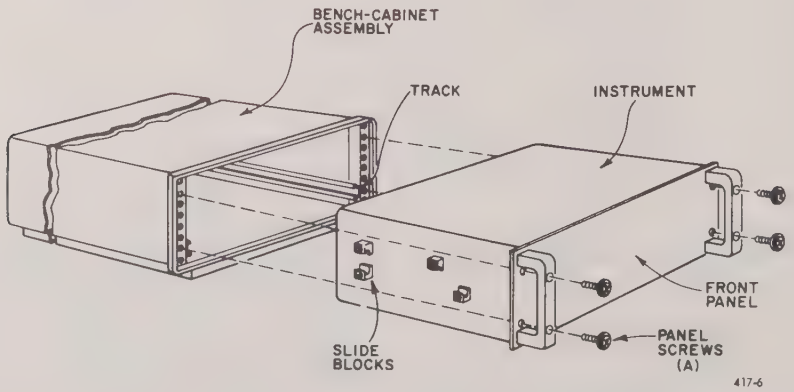


Figure 2-3. Bench cabinet assembly.

2.2.6 Rack Mounting.

A rack-mounting case (Figure 2-4) with installation hardware is provided with a rack-mount model. To install this model in a standard 19-in. relay-rack proceed as follows:

a. Remove the panel screws and withdraw the instrument until it stops. Lift the front and withdraw completely from the cabinet.

b. Insert the cabinet into the rack and secure it to the front of the rack with the four screws provided.

c. If the rack contains a rear support, remove the rear-cover screws and the rear cover from the case. Attach the brackets to the inner holes on the cabinet with the rear bracket screws and nuts provided. Use the set of slots that most nearly align the bracket with the rear support of the rack. Secure the brackets to the rack, each with two screws and nuts provided.

d. Push the track all the way into the case. Place the rear of the instrument into the cabinet, lifting it to straddle the tracks with the slide blocks. Push the instrument into the case until it stops. Lift the front, pull the instrument out so that the tracks follow and then push in so that the front slide blocks straddle the tracks. Slide the instrument all the way into the case and secure with four front-panel screws.

2.2.7 Conversion to Bench Mounting.

a. Order a 4173-4008 bench cabinet assembly (includes hardware set).

b. Disconnect any cables from the instrument, remove the front panel screws and withdraw the instrument from the rack cabinet.

c. Insert the instrument into the bench cabinet, straddling the tracks with the slide blocks. Secure the instrument with the four front-panel screws.

2.3 REMOTE PROGRAMMING CONNECTIONS.

2.3.1 General.

Both the master and slave versions of the unit can be programmed for remote control of output frequency and output level. Table 2-1 lists the three variations of the remote control mode.

Table 2-1
REMOTE-CONTROL-MODE VARIATIONS

OUTPUT	
Frequency	**Voltage**
Local	Remote
Remote	Local
Remote	Remote

Refer para. 3.5.2 and 3.5.3 for remote control operating instructions.

2.3.2 BCD FREQUENCY PROGRAM Socket.

Frequency programming connections are made to the rear-panel BCD FREQUENCY PROGRAM socket (Figure 1-2). This 50-pin Amphenol Type 57 socket (GR P/N 4230-4049) mates with a 50-pin Amphenol Type 57 plug (Amphenol P/N 57-40500).

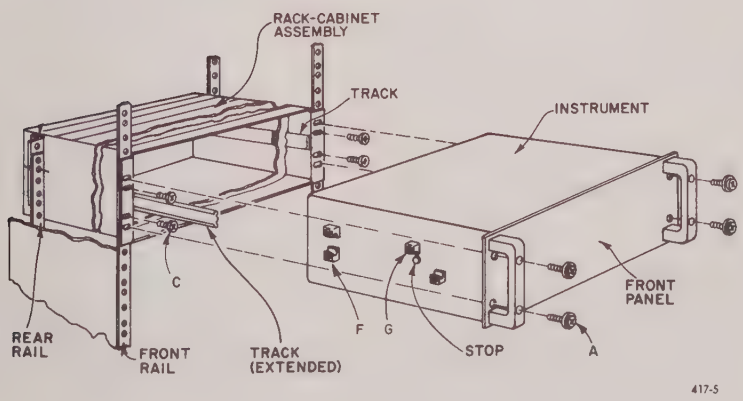


Figure 2-4. Method of mounting the relay-rack model.

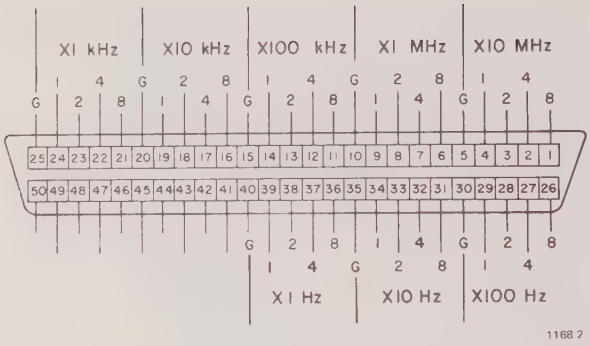


Figure 2-5. BCD FREQUENCY PROGRAM socket connections as viewed from the rear of the instrument.

The information provided in Figure 2-5 can be used to assemble a cable through which the synthesizer can be programmed. Connections can be made with any electrical wire or cable but it is recommended that 4-wire shielded cable be used — a separate one for each frequency decade. A separate ground terminal is provided adjacent to each group of four terminals, which can be used for connecting the shield of each cable. Cable resistance is completely negligible for lengths up to 100 ft.

The color-coding of the recommended cable-conductors should match the 1-2-4-8 code (brown, red, yellow, and grey) for easy identification within a cable. It is suggested that the individual cables be marked with color bands at each end to identify the rank of the decade it connects.

A strain relief should be used under the plug clamp to relieve the cable of strain and to avoid pinching the wires when the clamp is tightened. A simple strain relief can be made by wrapping electrical tape around the cable assembly and tightening the clamp around the tape.

All external frequency selection is by 1-2-4-8 BCD control with external program connections provided by a rear-panel multiple contact plug. Logic levels are +5 V for logic "0" and +0.5 V or less for logic "1". An internal 2-kΩ pull-up resistor is provided to keep all program lines at logic "0" unless the external circuit is completed to ground; 3 mA or less will program a logic 1. These levels are compatible with external DTL or TTL integrated circuit gates or inverters.

The switching speed for 100-kHz and above is $< 200\ \mu s$; for 10- and 1-kHz steps < 5 ms, and for 100-Hz steps and below < 50 ms.

2.3.3 LEVEL PROGRAM Connector.

When the front-panel OUTPUT level control is set to the REMOTE position, output level control is transferred to a dc voltage applied to the rear-panel BNC LEVEL PROGRAM connector. The rms OUTPUT voltage into 50Ω is 1/4 of the applied dc remote program voltage to within ±2 dB. Table 2-2 lists some rms output voltages produced by a corresponding remote program input level.

Program-level input impedance is greater than 100 kΩ. Output level response time, with external programming, is 90% complete in 10-ms for each step change.

2.4 POWER-LINE CONNECTION.

The power-transformer primary windings can be switched, by means of the two-position slide switch (Figure 1-2) on the rear panel, to accept a line voltage of 100 to 125 V or 200 to 250 V, 50 to 60 Hz. Operation at line frequencies up to 400 Hz, with lower line voltage limits of 105 or 210 V, is satisfactory.

Connect the 3-wire power cable (P/N 4200-9622) to the line and to the 3-terminal male connector (Figure 1-2) on the rear panel. A $\frac{6}{10}$-A fuse is used in the 100-V to 125-V circuit; A $\frac{3}{10}$-A fuse is used in the 200-V to 250-V circuit. Power consumption is approximately 50 W.

2.5 LINE-VOLTAGE REGULATION.

The accuracy of measurements accomplished with precision electronic test equipment operated from ac line sources can often be seriously degraded by fluctuations in primary input power. Line-voltage variations of ±15% are commonly encountered, even in laboratory environments. Although most modern electronic instruments incorporate some degree of regulation, possible power-source problems should be considered for every instrumentation setup. The use of line-voltage regulators between power lines and the test equipment is recommended as the only sure way to rule out the effects on measurement data of variations in line voltage.

The General Radio Type 1591 Variac® Automatic Voltage Regulator is a compact and inexpensive equipment capable of holding ac line voltage within 0.2% accuracy for input ranges of ±13%. It will assure, for example, that an instrument rated for 100-125 (or 200-250) V can be operated reliably in spite of varying input voltages in the range 85-135 (or 170-270) V. The 1 kVA capacity of the

Table 2-2
DC INPUT VS RMS OUTPUT

DC Input	RMS Output ±2 dB
0.5	0.125
0.8	0.2
1.0	0.25
1.5	0.375
2.0	0.5
2.5	0.625
3.0	0.75
3.5	0.875
4.0	1.0

1591 will handle a rack full of solid-state instrumentation with no distortion of the input waveform. This rugged electromechanical regulator comes in bench or rack-mount versions, each with sockets for standard 2- or 3-wire instrument power cords.

2.6 ENVIRONMENTAL CONDITIONS.

The instrument is designed to operate in a relay rack over the ambient air-temperature range, inside the rack, of 0 to 50°C. When mounted in a bench cabinet the outside air-temperature range is 0 to 50°C. The nonoperating storage-temperature range is −40°C to +75°C. Permissible maximum relative humidity of the ambient is 95% with the instrument operating. The instrument will withstand normal shock and vibration encountered in nonmobile applications. With more severe vibration conditions operation may operation may be satisfactory but the General Radio Company should be consulted for recommendations.

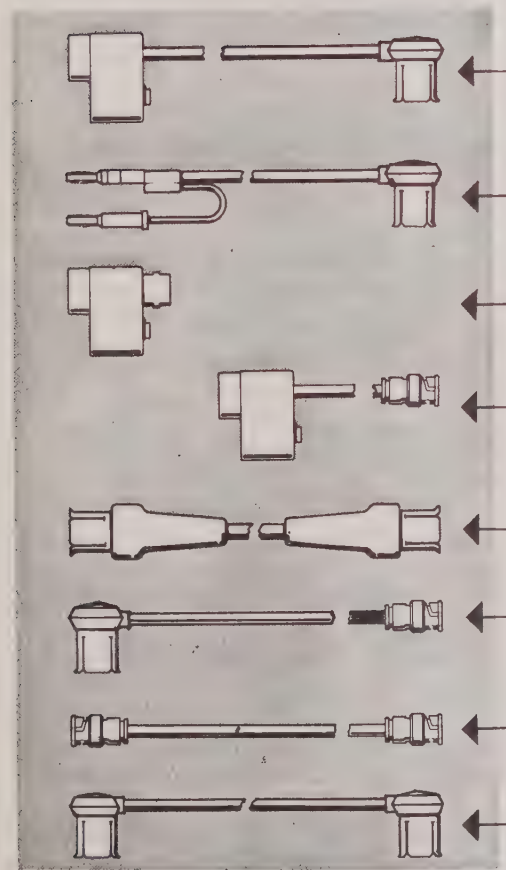
2.7 EXTERNAL BATTERY CONNECTOR.

A male connector, marked J2, on the master oscillator unit permits a "keep alive" battery (***not supplied***) to be connected to the crystal oven. Any 15 V to 18 V nickel cadmium battery is sufficient.

Make up a lead with a Sealectro SKT-1 or SKT-23 connector, which will mate with J2, on one end. Use this lead to connect the positive terminal to J2; use a clip lead to connect the negative terminal to the instrument chassis.

If used, the battery will maintain the crystal oven temperature in case of a power interruption. Internal diodes isolate the battery during normal operation and provide automatic switchover if ac power is removed.

Table 2-3
AVAILABLE INTERCONNECTION ACCESSORIES



874-R34	Coaxial patch cord, double plug to GR874, 36" long	0874-9692
874-R33	Coaxial patch cord, two plugs to GR874, 36" long	0874-9690
274-QBJ	Adaptor, shielded double plug to BNC jack	0274-9884
776-A	Patch cord, shielded double plug to BNC plug, 36" long	0776-9701
874-R22A	Coaxial patch cord GR874 to GR874, 36" long	0874-9682
776-B	Patch cord, GR874 (right-angle) to BNC plug, 36" long	0776-9702
776-C	Patch cord, BNC plug to BNC plug, 36" long	0776-9703
776-D	GR874 to GR874, both right-angle, 36" long	0776-9704

274-13XA

Operation—Section 3

3.1 GENERAL 3-1
3.2 INSTRUMENT TURN-ON 3-1
3.3 INSTRUMENT WARM-UP 3-1
3.4 OPERATIONAL CHECKS 3-1
3.5 MASTER VERSION 3-2
3.6 SLAVE VERSION 3-3

NOTE

For best accuracy, the synthesizer should be operated continuously.

3.1 GENERAL.

Operation of the Coherent Decade Frequency Synthesizer to generate precision-frequency sine waves is quite straightforward. For local control operation: apply power, set the frequency dials to the desired frequency, and adjust the signal level at the OUTPUT connector with the OUTPUT level control. The output frequency is displayed by the front-panel frequency dials. For remote control operation: apply power, set the FREQUENCY SELECT switch to REMOTE, connect a programming device to the BCD FREQUENCY PROGRAM and LEVEL PROGRAM connectors, and adjust the programming devices to obtain the required output frequency and output level.

3.2 INSTRUMENT TURN-ON.

Because the crystal oven should operate continuously, an on-off power switch is not provided with the master version synthesizer. Instrument turn-on is accomplished by connecting a 110 V or 230 V ac line to the rear-panel power connector.

The master version synthesizer uses a built-in precision quartz crystal oscillator for its internal driving source. This crystal is housed in a temperature-controlled oven, for optimum oscillator stability, and has a relatively long warm-up interval if the power is interrupted. A rear-panel connector (Figure 1-2) is provided for connecting an external battery to the crystal oven. This connection may be desirable in case of an emergency or if for some reason the unit has to be turned off. Refer to para. 2.7 for external battery information.

The slave-version synthesizer is equipped with a front-panel on-off power switch. Since the slave version has to be externally driven, an EXT LOCK FAIL lamp is not required. The power switch is installed in the hole vacated by the absence of this lamp. Both synthesizer versions have a front-panel power indicator lamp to indicate that the instrument is on.

3.3 INSTRUMENT WARM-UP.

Since the unit is all solid-state, except for the indicator lamps, no warm-up time is required to generate output. However, in applications where the synthesizer is phase-locked to an already operating external standard, such as the GR Type 1115 Standard Frequency Oscillator, it is necessary to allow complete equipment warm-up to a steady-state condition, if the ultimate in stability is required. Very small frequency errors, due to phase drifts of tuned circuits in the synthesizer, can be important in some demanding applications.

For extremely precise work, a warm-up period of two hours or more is recommended for the Master Unit precision oscillator and one hour for the Slave Unit. When feasible, round-the-clock operation is desirable, if high precision is apt to be required on short notice.

3.4 OPERATIONAL CHECKS.

3.4.1 General.

These procedures can be used for incoming inspection, operator familiarization, or as a periodic check on instrument operation. Table 5-1 includes test equipment used for operational checks. Refer to para. 5.5 if unable to obtain the performance called for in the operational checks.

3.4.2 Proper Frequency Generation.

For a quick check of proper frequency generation, use the following procedure:

a. Connect the power cord (supplied) between the rear-panel plug and an ac outlet.

b. Set the FREQUENCY SELECT control to LOCAL. The front-panel frequency dials are now effective.

c. Slave version only — apply an external frequency driving source to the rear-panel INPUT connector (1, Figure 1-3). Use the GR Type 1115 Standard Frequency Oscillator or another synthesizer.

NOTE

Omit step c for the master version.

d. Connect the OUTPUT connector (Figure 1-1) to INPUT A of the 1191/Z Counter. Use a GR 874-QBPAL adaptor and a 776-C patch cord.

e. Set the frequency dials to a frequency between 10 kHz - 159.999999 MHz.

f. Observe the counter visual register. It should display the same frequency set by the frequency dials.

3.4.3 OUTPUT Voltage Level.

a. Set the synthesizer to any frequency within its output-frequency range.

b. Connect the GR 1806-P1 Tee and 1806 probe and 50Ω termination to the synthesizer OUTPUT connector.

c. Adjust the synthesizer OUTPUT level control for maximum output.

d. Observe the 1806 indication, which should be within ±2dB of the level set by the synthesizer OUTPUT control.

3.4.4 Frequency Programming.

A switch or solid-state closure to ground will change the program lines from the "0" state to the "1" state. The frequency programming circuits can be functionally checked with a counter and a test lead that has a probe on one end and a clip on the other.

For example, adjust the controls for remote frequency operation and connect the 1191/Z counter to the output connector. Pick a frequency within the frequency range of the synthesizer and refer to Figure 2-5 for its corresponding terminal number. For this example we will use 10 MHz. Clip one end of the test lead to the chassis and touch the probe to terminal 4 of the BCD FREQUENCY PROGRAM socket. Observe the 10-MHz reading on the visual register of the counter. Note that the count disappears as soon as the short to ground is removed. This happens because all lines maintain logic 0 unless a closure to ground is made.

3.5 MASTER VERSION.

3.5.1 General.

Variations of each basic mode of operation, LOCAL and REMOTE control, make the master synthesizer the more versatile of the two versions. The variations of either control mode are: internal drive, internal drive-external lock, and external drive. Additional variations of the REMOTE control mode are: programmed output frequency, programmed output voltage, and programmed output frequency and voltage.

Changing from one mode, or mode variation, to another can be done quickly and easily by flipping a switch, or making or breaking a rear-panel connection.

3.5.2 Local or Remote Control.

Internal-Drive. Set the controls as follows for internal-drive operation:

Line Voltage Switch	Required Line Voltage
S1	LOCK
FREQUENCY SELECT	LOCAL OR REMOTE
Frequency Dials	Required Frequency
OUTPUT Voltage Control	Required Level

In this mode of operation, the internal master oscillator is used as the synthesizer driving source and determines output frequency stability.

Internal Drive-External Lock. Make the connection and set the controls as follows for internal drive-external lock operation:

5 MHz LOCK Connector	Connect External Lock Source*
All other controls	Same as Internal Drive

This method of operation uses the master oscillator as the driving source but uses an external source, such as the General Radio Type 1115 Standard Frequency Oscillator, to phase-lock the master oscillator. The only useful application is one requiring greater stability than that of the internal oscillator ($<2X10^{-10}$/°C from 0 to 50°C when operated continuously).

External Drive. Make the connection and set the controls as follows for external-drive operation:

S1	DRIVE
10 MHz DRIVE Connector	Connect 10-MHz Precision Source**
All other controls	Same as internal drive

Setting S1 to DRIVE disables the internal oscillator and connects the rear-panel DRIVE connector directly to an amplifier in section Y. This method of operation is useful in case of master-oscillator failure or power interruptions that impair oscillator stability.

*The lock source can be any precision 5-MHz source (or integer sub-multiple down to 100 kHz). The output level should be a minimum of 0.1 V rms into 1 kΩ or a maximum of 3 Vrms into 50 Ω.

**The external drive level must be 0.5 V ±0.05 V rms into 50 Ω.

3.5.3 Remote Control Only.

The two rear-panel programming connections, one for output frequency and one for output voltage, facilitate the remote-control mode variations outlined below.

For remote-control operation, first adjust the unit for one of the mode variations in para. 3.5.2., then follow the instructions of para. 3.5.3.

Output Frequency. Make the connection and set the controls as follows for remote control of Output Frequency (refer to para. 2.3.2):

BCD FREQUENCY PROGRAM Socket . . . . Connect Programming Unit
FREQUENCY SELECT . . . . . REMOTE
OUTPUT Voltage Control . . . . . Required Level

Output Voltage. Make the connection and set the controls as follows for remote control of output voltage (refer to para. 2.3.3):

LEVEL PROGRAM Connector . . . . . Connect Programming Unit
OUTPUT Voltage Control . . . . . REMOTE
FREQUENCY SELECT . . . . . LOCAL
Frequency Dials . . . . . Required Frequency

Output Frequency and Voltage. Make the connections and set the controls as follows for remote control of output frequency and voltage (Refer to para. 2.3.2 and 2.3.3):

BCD FREQUENCY PROGRAM Socket . . . . Connect Programming Unit
LEVEL PROGRAM Connector . . . . . Connect Programming Unit
FREQUENCY SELECT . . . . . REMOTE
OUTPUT Voltage Control . . . . . REMOTE

Ganged switches, operated by the FREQUENCY SELECT control, transfer connections from the front-panel frequency dials to the rear-panel BCD FREQUENCY PROGRAM socket, when set to REMOTE position. Switching to REMOTE also energizes the REMOTE FREQUENCY SELECT indicator lamp.

Setting the OUTPUT voltage control to REMOTE switches out the panel control and connects the rear-panel LEVEL PROGRAM connector.

3.6 SLAVE VERSION.

3.6.1 General.

A slave version of the unit was designed for applications that presently have a precision frequency source suitable for driving the synthesizer. This source can be the auxiliary 10-MHz output of a master unit or another slave unit, or any other precision 5- or 10-MHz source.

A rear-panel BNC connector (1 Figure 1-3) is provided for connecting the external driving source to the EXTERNAL DRIVE INPUT MODULE. The driving source frequency must be 5- or 10-MHz, and the two-position switch (2 Figure 1-3) must be set to the same frequency that is applied to the rear-panel INPUT connector.

3.6.2 Local Control.

Make the connection and set the controls as follows for Local Control operation:

INPUT Switch . . . . . Set to 5 MHz or 10 MHz
INPUT Connector . .Connect Frequency Driving Source
Line Voltage Switch . . . . . Required Line Voltage
FREQUENCY SELECT . . . . . LOCAL
Frequency Dials . . . . . Required Frequency
Power Switch . . . . . ON
OUTPUT Voltage Control . . . . . Required Level

3.6.3 Remote Control.

Make the connections and set the controls as follows for Remote-Control operation.

INPUT Switch . . . . . Set to 5 MHz or 10 MHz
INPUT Connector . Connect EXT. Freq. Driving Source
FREQUENCY SELECT . . . . . REMOTE
All other controls . . . Same as para. 3.5.3 (as required)

The remote-control mode variations for the slave version synthesizer are identical to those for the master version. Refer to para. 3.5.3 for operating instructions for the remote-control mode variations.

Theory–Section 4

4.1 GENERAL 4-1
4.2 SYNTHESIZING PROCESS 4-2
4.3 CIRCUIT ANALYSIS 4-3

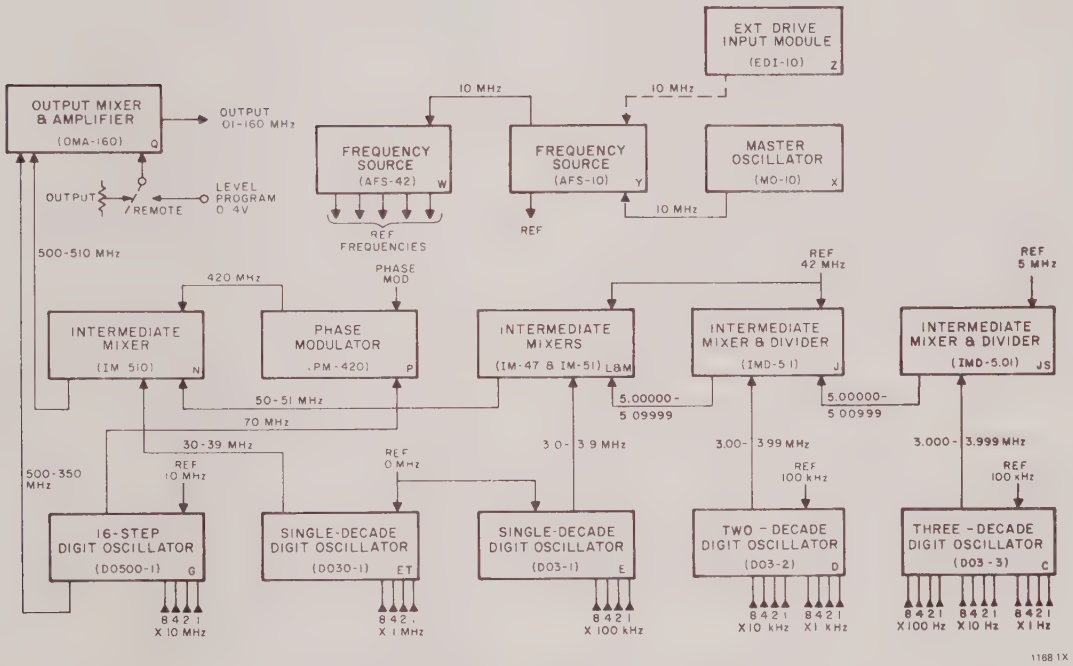


Figure 4-1. Simplified block diagram of the Synthesizer.

4.1 GENERAL.

This section contains a functional description to the simplified block diagram level of Figure 4-1, and a more detailed circuit analysis. For a detailed block diagram with each block representing a functional and physical part of the instrument refer to Figure 6-3.

Paragraph 4.2 is a block diagram level description of circuit operation and uses the section names silkscreened on the bottom cover of each compartment to refer to a particular section. (EX. section Y or section W).

The more detailed circuit analysis has a separate paragraph for each section and uses both sectional and functional names to refer to a particular section. Included in each paragraph title is a reference to the schematic for that section.

Negative logic is used and the nominal programming levels are +5 V for binary zero "0" and 0 V for binary one "1". Internal biasing holds the programming lines at the +5 V potential, with no external circuit closures, permitting simple circuit closures to ground to program each decade. A maximum current of 3 mA is required at 0 V on any program line. The maximum permissible voltage to program a binary "1" is +0.5 V and for a binary "0" is +5.0 V. These levels are compatible with DTL or TTL integrated circuits, however, buffers may be required for inversion or to insure that the required programming levels are obtained.

When the front-panel OUTPUT level control is in the REMOTE position, control of the output level is transferred to a dc voltage that is applied to the rear-panel BNC LEVEL PROGRAM connector. The rms output voltage, into a 50 Ω impedance, is 1/4 of the applied dc voltage and the programming unit sees an impedance greater than 100 kΩ.

4.2 SYNTHESIZING PROCESS.

The unit derives its output frequency from a single reference source by means of some combination of arithmetic operations on frequency (addition, subtraction, multiplication, and division). This process starts in the master oscillator (section X of a master-version synthesizer) or the External Drive Input Unit (section Z of a slave-version synthesizer). Section X generates the 10-MHz drive signal and its frequency can be phase-locked to an external lock source. (The external lock-source connection is made to section X, but the lock circuits are located in section Y.)

Section Z, a substitute module for section X, must be externally driven and provides a 10-MHz drive signal to section Y. Refer to paragraph 4.3.2 for detailed operation. Section Y contains, in addition to the phase-lock circuits (master unit only) four 10-MHz buffer amplifiers. One of these feeds the rear-panel 10-MHz output connector, another feeds section G, the third feeds section W. Section W synthesizes, by frequency division and multiplication, all the additional reference frequencies required.

The output frequency is produced by combining the frequencies of 5 digit oscillators, one of which provides 3 decades of control. The latter is section C (DO 3-3) at the beginning of the stepped-frequency chain.

Section C (DO3-3) produces an output of 3.000 to 3.999 MHz in 1-kHz steps. It does this by dividing its output frequency by 3,000 to 3,999 to produce 1 kHz, compares this in a phase detector with the 100-kHz reference input divided by 100 (=1 kHz), and uses the error signal to phase-lock the oscillator. The external control of the 3,000 to 3,999 scale-of-n divider, is provided by a 3-decade BCD input or by the X 1 Hz, X 10 Hz, and X 100 Hz dials. The output of section C feeds section JS.

Section JS (IMD 5.01) adds 5 MHz and 42 MHz from section W. The 47 MHz is then added to the 3.000- to 3.999-MHz signal from section C, divided by 10, added to 45 MHz, divided by 10 and the resulting 5.00000- to 5.00999-MHz signal fed to section J. A division of 10:1 in section J, in addition to the 100:1 division in this section, produces the 1-, 10- and 100-Hz steps from the 1-, 10- and 100-kHz steps of section C.

Section D (D0-3-2) produces an output of 3.00 to 3.99 MHz in 10-kHz steps. It does this by dividing its output frequency by 3.00 to 3.99 to produce 1 kHz, compares this in a phase detector with the 100-kHz reference input divided by 10 (=10 kHz), and uses the error signal to phase-lock the oscillator. The external control of the scale-of-n-divider is by a 2-decade, BCD input or by the x1-kHz and x10-kHz dials. The output of section D feeds section J.

Section J (IMD 5.1) adds 5.00000-5.00999 MHz and 42 MHz from sections JS and W, respectively. The resulting 47.00000 to 47.00999 MHz is added to the 3.00- to 3.99-MHz from section D and divided by 10 to prodice a 5.000000- to 5.099999-MHz output to section L. This division produces 1- and 10-kHz steps from the 10- and 100-kHz steps of section D.

Section L (IM-47) adds the 5.000000- to 5.099999-MHz input from section J to its 42-MHz reference input to produce 47.000000 to 47.099999 MHz, which is filtered and fed to section M (IM-51).

Section E produces an output from 3.0 to 3.9 MHz in 100-kHz steps. This is accomplished by an oscillator in the 30- to 39-MHz frequency range, that is phase-locked to multiples of the 1-MHz reference input. Its frequency selection input is BCD, decoded to 10 line, which sets 10 different bias levels in the oscillator control circuit to bring it to frequency. A sampled phase-lock system then locks the oscillator to the reference input frequency at the proper 1-MHz multiple. A frequency division by 10 produces the desired output of 3.0 to 3.9 MHz, in 100-kHz steps, to section M.

Section M (IM-51) adds the 47.000000- to 47.099999-MHz input from section L to the 3.0 to 3.9 MHz, from section E, to produce 50.000000 to 50.999999 MHz, which is filtered and fed to section N.

Section ET (D030-1) produces an output of 30- to 39-MHz in 1-MHz steps. It is identical to section E except that it does not divide the output of the phase-locked oscillator. The output from this section is applied to section N.

Section G (DO 500-1) produces an output of 500-MHz down to 350-MHz in 10-MHz steps. It does this with an oscillator, which is phase-locked to multiples of its 10-MHz reference frequency input. It also produces a 70-MHz output by selecting the 7th harmonic of this same reference. This signal is fed to section P. The step frequency selection is obtained by roughly programming the oscillator to the desired frequency with a dc voltage on its frequency control line, and adding the output from a sampled phase detector, driven by the 10-MHz reference, to achieve phase-lock at the desired multiple of 10 MHz. All 16 combinations of the 4-line binary-coded input are used to produce the 16 steps of output frequency. For local control, two panel dials are required that are mechanically interlocked to limit the selection to the 16 steps. The output from this section is applied to section Q.

Section P (PM-420) takes its 70-MHz input from section G, shifts its phase in accordance with the instantaneous voltage applied at the PHASE MOD input (rear-panel), and *multiplies* the frequency and phase shift by 6 to produce the 420-MHz output to section N.

Section N (IM-510) adds the 420-MHz input from section P to the 50.000000-50.999999 MHz from section M to produce 470.000000 to 470.999999 MHz. After filtering, this is added to the 30- to 39-MHz input in 1-MHz steps, from section ET, to produce 500.000000 to 509.999999 MHz. This is filtered and fed to section Q.

Section Q (OMA-160) receives two inputs: 500.000000- to 509.999999-MHz from section N and 500- to 350-MHz in 10-MHz steps from section G. These two inputs are subtracted to produce 0 to 159.999999 MHz. Note that all digits now correspond to the frequency control inputs to sections G, ET, E, D and C; the first two digits are controlled by section G and the last three by section C. The lowest usable frequency in section Q is limited to 10 kHz.

4.3 CIRCUIT ANALYSIS.

4.3.1 Section X (Figure 6-7).

The master oscillator can be switched off and an external source used to drive the synthesizer. When this method of operation is used, the frequency of the external source must be 10 MHz and its output level must be 0.5 V ±0.05 V into 50Ω.

Setting switch S1 to 10 MHz DRIVE removes the 18 V supply, for the oscillator and the locking circuits in section Y, and allows the synthesizer to be driven with an external source. If this mode of operation is used, the temperature-controlled oven for the oscillator crystal is turned off and sufficient warm-up time must be allowed when internal control is restored.

If the ac supply is interrupted, diodes CR1 and CR2 permit automatic switch over to an external battery, if connected. Reapplying ac power, causes CR1 to conduct and turns off CR2, which automatically turns off the external battery. If the master oscillator is to be externally phase-locked, a precision 5-MHz source, or one with a frequency that is an integer submultiple thereof down to 100 kHz with an amplitude of 0.1 V (min.) into 50 Ω, will control the internal oscillator. The external lock signal is applied to the rear-panel LOCK connector and is fed straight through section X to the lock circuits in section Y.

Switch, S2 associated with the rear-panel LOCK connector, serves two functions: it permits oscillator varactor control from section Y to be applied by switching off Q2, and enables the EXT LOCK FAIL warning light circuit when a connection is made to the 5-MHz LOCK connector. With S1 set to the LOCK position, the master oscillator is used and the lock-fail circuits are disabled. The output to section Y is adjusted, by R1, to 0.21 V rms into 100 Ω.

4.3.2 Section Z (Figure 6-8).

Section Z is the External Drive Input Unit and can be switched for an input of 5 MHz or 10 MHz. At either frequency the input level must be at least 0.13 V into 50 Ω

With the INPUT Switch set to 10 MHz, an input signal of 10-MHz applied to the INPUT Connector will provide a 10-MHz signal for the input to Q1. Likewise, with the INPUT switch set to 5 MHz, an input signal of 5-MHz applied to the input connector will also provide a 10-MHz signal to the input of Q1. The switch opens one arm of a push-push diode doubler to permit the 10-MHz input to drive Q1.

The remainder of the circuit consists of a limiting amplifier with a double-tuned output transformer, which supplies the 10-MHz signal, at a level of 0.21 V rms into 100 Ω, for section Y. To obtain the required output, L3 and L4 are peaked for 10 MHz and R7 is set for 0.21 V rms.

4.3.3 Section Y (Figure 6-12).

The lock-signal input to the 10-MHz Ancillary Frequency Source is clipped by diodes CR1 and CR2 and applied to an input pulse shaper (IC1) on the Lock Board (YA) of section Y. The pulse output of IC1 is amplified and fed through a bandpass filter. Adjustable coils (L1 and L2) in the filter are tuned for 5 MHz, with a signal applied to the rear-panel lock connector. The filter output is fed to a limiter circuit (IC2), which again clips the signal and produces the balanced phase detector drive.

Four diodes (CR5-CR8) are used in the phase detector in a full-wave arrangement. They are floating with respect to dc ground so that the OSC VARACTOR BIAS INPUT, from section X, can be applied in series with the error signal developed by the phase detector, to provide the OSC VARACTOR CONTROL OUTPUT to section X. Potentiometer R22 is used to adjust zero dc offset between the OSC VARACTOR BIAS INPUT and OSC VARACTOR CONTROL OUTPUT.

There are two interconnected detectors (a no-reference signal detector and a phase-lock detector) for sensing the lack of a reference-input signal or a beat-frequency signal on the varactor control output. Either condition energizes the output to the EXT LOCK FAIL warning light.

Buffer Board (YB) carries four 10-MHz amplifiers. Amplifier Q5 drives the rear-panel 10 MHz OUT connector, Q4 drives section G, Q1 drives a trigger circuit on the Divider Board (WA), and the output from Q3 is unused. Capacitors C1, C8, C22, and C24 are used to tune the amplifiers for maximum output.

4.3.4 Section W (Figure 6-16).

The WA board, of this Ancillary Frequency Source, receives a 10-MHz input from section Y. This signal triggers switching transistor Q1 and drives a dual flip-flop (IC1), which has three separate 5-MHz outputs. One of these outputs is fed to section Y, via a low-pass filter, a second to section JS via a low-pass filter, and the third output drives divider circuit WAIC2, which provides three isolated 1-MHz outputs at pins 8, 11 and 12.

The output from pin 8 drives the rear-panel connection of the unit via an emitter-follower circuit (Q4). Divider circuit IC3 is driven by the output from IC2, pin 11 and the third 1-MHz output from IC2, pin 12 feeds two common emitter stages Q2 and Q3.

Transistors Q2 and Q3 provide 1-MHz outputs at pins WA20 and WA22 respectively. Transformers T1 and T2 are used to tune these stages for maximum output at 1 MHz.

The output from WA20 is used as a reference in section ET, and the other output is fed to a clipper circuit on the WB board of section W.

IC3 provides 100- and 500-kHz outputs from the WA board. One of these is a 100-kHz output signal from WA43 that feeds section D, and a parallel connection to WA41 that feeds section C. A 500-kHz signal is available at WA45 but is unused. All of the outputs from IC3 are unfiltered and have rectangular waveforms.

The WB board receives a 1-MHz input from the WA board and produces the 42-MHz outputs by frequency multiplication. The first stage is an emitter-coupled clipper followed by a single-pole and a two-pole 7-MHz filter, separated by a common-base amplifier that provides a 7-MHz drive to a second emitter-coupled clipper. This is followed by two single-pole 21-MHz filters separated by another common-base amplifier that provides the 21-MHz drive to a push-push diode doubler. The doubler drives another common base amplifier followed by a resonant transformer to provide the 42-MHz outputs on parallel terminals WB36, WB38, WB42 and WB44. Terminal WB42 provides a 42-MHz output to section J, WB44 a 42-MHz to section L, and WB36 42-MHz to section JS. Adjustable components L1, L2, L3, L4, L5, T1, and T2, are all tuned for 42-MHz outputs. R16 sets the level.

4.3.5 Section C (Figure 6-20).

Section C is a three-decade Digit Oscillator with a 3 to 3.999 MHz output. It uses a scale-of-n divider in its lock loop and provides three decades of frequency control of the synthesized OUTPUT, in 1-Hz, 10-Hz and 100-Hz steps. The frequency at the output of section C covers 3.000 to 3.999 MHz in 1-kHz steps and the reference input is 100 kHz which is divided by 100 to produce 1 kHz. This 1-kHz input to CA44 drives a ramp generator. The circuit generates a nonlinear ramp, which compensates for gain variations in the phase-lock loop, due to the nonlinear control characteristics of the variable-capacitance diode (CR9), and due to the variation in the division ratio of the scale-of-n divider. The total slope variation of the ramp, from the low voltage to the high voltage end, is approximately 1 to 4. The ramp starts at essentially 0 V and has a peak amplitude of 10 volts, set by R-17. This voltage appears across C5. C5 is discharged by the amplified 1-kHz INPUT REF pulse, and the start of the ramp is accurately timed by the trailing edge of this pulse.

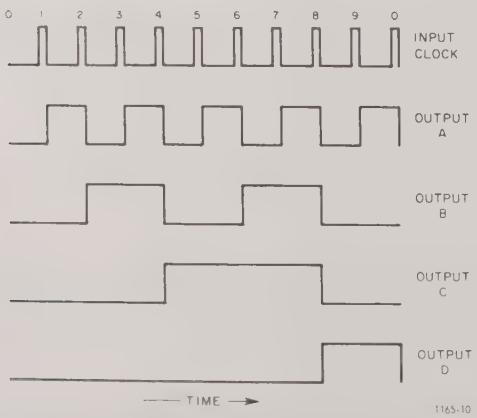


Figure 4-2. Timing diagram for divider circuits IC1 and IC2 on the program board (CB).

The phase-lock control voltage for the oscillator is produced by sampling the reference ramp with the 1-kHz input from the CB board. This input is a pulse of 0.4 μs duration and connects C6 to the ramp generator by opening the sampling gate for this duration. Since C6 is connected to the very high input impedance of the Filter/Amplifier, and since the sampling gate has extremely low leakage when closed, the voltage obtained during one sampling interval is retained with very little ramp off until the next sample is obtained 1 ms later. The dc voltage gain of the Filter Amplifier is unity, so the voltage on C6 is the voltage for CR9. The control action of this circuit will cause the frequency of the oscillator to be changed until the ramp is repetitively sampled at exactly the right time to produce the required control voltage. The Filter/Amplifier has an RC filter at its input, with feedback to a capacitor, to produce a sharp cut-off characteristic. There is a passive single-pole RC filter between this amplifier and CR9. Both of these filters are bypassed by back-to-back diodes to minimize time for oscillator lock-up, when the programmed frequency is changed. The purpose of the filtering is to minimize sidebands at the 1-kHz sampling rate, and to limit the frequency range of noise sidebands produced by the reference input.

The oscillator and rf amplifier use dual-insulated-gate, field-effect transistors to minimize loading on the relatively high impedance L-C frequency determining circuit (consisting principally of the variable capacitance diode and inductor L1). The oscillator amplitude is set by C13. The pulse output to drive the scale-of-n divider, on board CB, is obtained by resistance coupling from the drain circuit of the oscillator transistor and a two stage amplifier.

The divider consists of three identical programmable decades (IC8-IC10) followed by a dual flip-flop IC6 and a number of gates to program and reset the dividers to produce division by 3,000 to 3,999. Operation is continuous since reset is completed between input pulses. To minimize effects of propogation time and to simplify the programming of each decade, the coding system summarized in TABLE 4-1 is used. Note that two recognition states are used, with the decade reset to the compliment of these states, to produce the required division ratio. For relation to the schematic and to points on the circuit board, note that IC output A, B, C, and D correspond to IC terminal numbers 5, 9, 2, and 12 respectively.

The programmable decades operate as any decade divider, except that when a reset pulse occurs, the data

input derived from the program lines is *strobed* into the decade. The reset pulse occurs when, and only when, the coded output for the selected digit numbers occur at all decades, and the dual flip-flops have accumulated a count of 3.

Individual diodes, as well as integrated circuit gates; are used in the system. A careful study of Figures 6-20, 4-2 and Table 4-1 will reveal that recognition of the last bit of coded information, to initiate a reset pulse, occurs in the very first flip-flop in the first decade with all other gates open and waiting. The recognition pulse triggers a reset pulse generator, which increases the duration of the pulse sufficiently to override the memory of pre-existing states in all decades. This pulse is negative going, and in the case of the decades, strobes in the coded data set by the control lines. The same pulse resets the dual flip-flops to zero. At the end of the reset pulse the divider is immediately ready for another clock pulse. Since the duration of the reset pulse is less than the interval between clock pulses, not a single input pulse is lost and the divider functions continuously as required. A somewhat longer duration strobe pulse is required for best operation of the sampled phase detector (CA board) so an additional pulse generator is used to produce the O/N output of the CB board.

4.3.6 Section JS (Figure 6-57).

Section JS is an intermediate mixer/divider with a 5.00000- to 5.00999-MHz output. The circuitry is divided between two etched-circuit boards JC and JB.

A 42-MHz signal from section W is amplified by Q2 and fed through a tuned circuit (L2 peaked at 42 MHz). This signal is added to a 5-MHz signal from the JB Board, and then fed through a two-pole filter (coils L3 and L4 tuned for maximum output) to a 47-MHz amplifier (Q3). The output of the amplifier is fed through a single-pole filter (L5 tuned for maximum output) and used as the input to a balanced mixer (Q4 and Q5).

The balanced input to the mixer is produced by a resonant transformer (T2), driven by the 3.000- to 3.999-MHz input from section C. A balanced-to-unbalanced transformation occurs in another two-pole filter at the output of this mixer.

The 2-pole filter is adjusted by setting C16 and L7 for the flattest maximum response. The core of L6 is set to the center of the coil and is not used for adjusting filter response. Its output of 50.000 to 50.999 MHz drives a decade frequency divider IC1,which is a high-speed flip-flop providing a 2:1 division. The buffered output of IC1 drives

Table 4-1
PROGRAM CODING OF DECADES IN SCALE OF N DIVIDER

Decimal Program	Binary State Program				Reset				Recognize			
	A	B	C	D	A	B	C	D	A	B	C	D
0	0	0	0	0	1	0	1	0	1	0	1	0
1	1	0	0	0	0	0	1	0	1	0	1	0
2	0	1	0	0	1	1	0	0	1	0	1	0
3	1	1	0	0	0	1	1	0	1	0	0	1
4	0	0	1	0	1	0	1	0	1	0	0	1
5	1	0	1	0	0	0	1	0	1	0	0	1
6	0	1	1	0	1	1	0	0	1	0	0	1
7	1	1	1	0	0	1	0	0	1	0	0	1
8	0	0	0	1	1	0	0	0	1	0	0	1
9	1	0	0	1	0	0	0	0	1	0	0	1

the 5:1 divider IC2. A single-pole filter, following IC2 provides the 5.0000 to 5.0999-MHz sinewave balanced output to the JB Board. This filter is adjusted by setting C26 for maximum output at the frequency range center.

A 5-MHz signal from WA6 is fed to JB3. This signal is routed to JC41 via JB5. It is also multiplied by 9 in 2 frequency-tripler circuits and the resulting 45-MHz (peaked by C6, C10, L4, and L5) is added in Q4 and Q5 to the 5.0000-5.0999 balanced input to terminals JB44 and JB43. The resulting 50.0000- to 50.0999-MHz signal, peaked by C21 and L7 (core of C6 set to center), is then divided by 10 and fed to section J, via a filter tuned by C31 for maximum output at the center of the 5.00000- to 5.00999-MHz frequency range.

4.3.7 Section D (Figure 6-61).

The circuitry for section D is identical to section C with the following exceptions: (1) X10 faster switching time, (2) divides the 100-kHz reference signal from section W by 10, to produce the 10-kHz input reference to CA44, (3) manually controlled by the 1-kHz and 10-kHz front-panel frequency dials (only 2 programmable decades); (4) and the output frequency is 3.00 to 3.99 MHz. With these facts in mind refer to para. 4.3.5 for detailed circuit theory.

4.3.8 Section J (Figure 6-23).

Section J is an intermediate Mixer/Divider with a 5.000000- to 5.099999-MHz output. Its circuitry is carried by a single etched-circuit board (JA), which is identical to the JC Board of section JS with the following exceptions: (1) the input frequency to terminal 41 is 5.00000 to 5.00999 MHz and is fed unbalanced to section J by a coaxial connection; (2) the input frequency to terminal 19 is 3.00 to 3.99 MHz.

4.3.9 Section L (Figure 6-26).

Section L is an Intermediate Mixer that adds the 5.000000- to 5.099999-MHz input, from section J, to the buffered 42-MHz reference frequency, from section W, and produces a 47.000000- to 47.099999-MHz output. The 42-MHz input is amplified in Q2 and fed through a filter to a mixer circuit. The filter is adjusted by peaking L2 for maximum output. Input 5.000000- to 5.099999-MHz is fed to the same mixer circuit, combined with the 42-MHz signal, fed through another double-pole, bandpass filter to the output of section L. Both double-pole bandpass filters are adjusted by L3, L4, L5 and L6 for flattest maximum output response over the 5.000000- to 5.099999-MHz input range.

4.3.10 Section E. (Figure 6-30).

Section E is a Digit Oscillator with an output of 3 to 3.9 MHz. It provides a single decade of frequency control at the OUTPUT of the synthesizer in 100-kHz steps. The oscillator frequency is determined by an L-C circuit composed of an adjustable inductor (L1) in parallel with two series-connected variable-capacitance diodes (CR1 and CR2). This oscillator covers the frequency range of 30- to 39-MHz and feeds the loop buffer amplifier (Q3) and the output amplifier (Q2). These in turn feed two outputs to the EB Board.

The control signal to CR1 and CR2 passes through a loop filter with a rejection notch, at the 1-MHz sampling frequency, and with RC lead-lag elements to control loop response. The loop filter is fed by a control signal, consisting of the Oscillator Control Input attenuated by a 10-position resistive voltage divider. The control for this divider is derived from the BCD Frequency Control input by a BCD-to-decimal decoder and a series of 9 transistor switches. The switches select a separate adjustable resistor for each frequency step from 30 to 38 MHz; 39 MHz is selected with all switches open. The Oscillator Control Input voltage consists of the amplified error signal produced by the sampling bridge on the EB board. The switched voltage divider selects a dc level to roughly tune the oscillator to the selected frequency, and the error signal from the sampling bridge locks the frequency to an exact multiple of the reference input.

The dc control voltage results from the fact that the cathodes of the variable capacitance diodes and the low side of the stepped voltage divider are returned to a positive dc voltage of almost 18 V, while the Oscillator Control Input is near 0 V dc. A fixed voltage divider, consisting of R19 and R29, sets the voltage applied to the variable capacitance diodes to approximately +15 volts at the anodes for the 39-MHz step. Additional adjustable resistors (R10 —R18) are switched, one at a time, to shunt R29 to produce lower voltages for all other frequency steps. The actual voltage applied across the diodes is reduced by the forward voltage drop across the silicon junction diode CR3, for temperature compensation. Loop gain variation versus frequency, due to the nonlinear control characteristics of the diodes, is effectively eliminated by the variable attenuation of the Oscillator Control Input with the switched Voltage Divider.

The pulse generator (EB board) consists of an amplifier clipper and is driven by the 1-MHz reference input, which is followed by a blocking oscillator. This oscillator drives a snap-off diode (CR6) and a series clipper (CR5) drives the sampling bridge via transformer T1. R18 sets the sampling pulse amplitude, which effectively sets the duration of the sampling interval. The sine-wave LOOP RF INPUT from the EA board is sampled by the diode bridge (CR1A — CR1D). The samples are stored in C1 and applied to a very high input-impedance dc amplifier, which feeds the OSC CONTROL OUTPUT to the EA board. The 30- to 39-MHz INPUT from the EA board is divided by 10 in two integrated circuits (IC2 and IC1) and, after filtering to obtain a sinusoidal waveform, becomes the 3.0- to 3.9-MHz OUTPUT of section E. Potentiometer R35 sets the output level.

4.3.11 Section M (Figure 6-33).

Section M is an Intermediate Mixer with an output of 50- to 51-MHz. The circuit for this section is carried by a single etched-circuit board, MA. The 47.000000- to 47.099999-MHz input from section L and the 3.0- to 3.9-MHz input from section E are added to produce 50.000000 to 50.999999 MHz in a plug-in, double-balanced mixer (IC1). The mixer is followed by a two-pole bandpass filter, an amplifier (Q1), and a three-pole bandpass filter. Both filters are set for maximum midrange output by L1, L2, L3, L4 and L5. The output of this section is connected to section N.

4.3.12 Section ET (Figure 6-37).

Section ET is a Digit Oscillator with an output of 30- to 39-MHz. It provides a single decade of frequency control at the synthesizer output in 1-MHz steps.

There are two etched-circuit boards for this section (EA and EC). The EA board is identical to the EA board in section E; the EC board is the same as the EB board except the 10:1 divider circuits are omitted. Circuit Analysis for section E (Para. 4.3.8) applies to section ET, except for the divider on the EB board.

Adjustments for this section are identical to section E, except there is no output level adjustment and the X1-MHz frequency dial controls this section. The output comes directly from the EA board and is fed to section N.

4.3.13 Section G (Figure 6-41).

Section G Provides 16 steps of 10-MHz frequency control at the OUTPUT of the synthesizer. The output frequency range is 500 down to 350 MHz in 10-MHz steps, and the reference-input frequency is 10 MHz. There are two etched-circuit boards.

The GA board carries the voltage-controlled oscillator, two buffer amplifiers and a program section that supplies 16 steps of DC PROGRAM voltage to the GB board from the four-line binary-coded control input. The three-stage buffer amplifier (Q4, Q5, and Q6), broadly tuned by coils in each collector circuit, prevents rf leakage from the sampler back to the oscillator. Another buffer amplifier (Q1 and Q2) isolates the load from the oscillator to prevent frequency variations. Potentiometers R51, R46, R45, R44, and R43 set the voltage-control-steps (from the dc programmer), which are used as the dc program input to the GB board.

The GB board carries the sampling pulse generator, 70 MHz output amplifier, sampling bridge, linearizing control amplifier and a switchable loop filter circuit. A pulse generator (CR14), fed by the 10-MHz input from section Y, applies ac pulses to the sampling bridge via a balanced to unbalanced transformer. For the duration of a pulse (0.5 ns), current is forced through all four diodes in the sampling bridge. For this short time span, the bridge looks at the rf signal superimposed on the dc program voltage. The sampling bridge then produces a signal that is the sum of the instantaneous rf and dc signals. This signal is amplified and applied to the varactors for phase error correction. The loop filter, between the dc amplifier and varactors, is automatically switched in after the varactor oscillator is captured.

Pulse-level adjustment for diode CR14 is set by R65. Potentiometer R50 is used to adjust the sampler balance. R36 balances the input current to the loop amplifier and minimizes leakage from the sample-hold capacitor C15. All other potentiometers set the transfer characteristics of the loop amplifier and linearize the over-all frequency-control system.

4.3.14 Section P (Figure 6-45).

Section P is a Phase Modulator with a 420-MHz output. The PA board receives a 70-MHz reference-frequency input from Section G, passes it through a two-pole bandpass filter, voltage controlled phase shifter, and a buffer/amplifier with a resonant-transformer output to the PB board. The voltage-controlled phase shifter consists of a variable capacitance diode (CR1) in a LC bridged-T arrangement for linearity compensation. CR1 is driven by a dc amplifier whose input is the Phase Modulation input to the PA board.

A Zener diode, in the output of the dc amplifier, provides the dc offset bias for CR1.

There are six adjustable elements on the PA board. If these adjustments are made in the field, they should be adjusted at the same time as those on the PB board. It is essential that a special enclosure cover with access holes for the adjustments be used. The adjustment procedure is as follows. Peak L1, L2, and L5 and the capacitors on the PB board for maximum 420-MHz output from the PB board. Adjust R22 for a 6-dBm output from the PB board. (.45 V into 50 Ω). Apply ±1.57 V dc to the PHASE MOD input to the instrument and check the phase shift at the OUTPUT of the instrument for ±90° phase shift within 5%. If phase shift is not symmetrical, increase inductance of L5 slightly but not more than that which reduces the 420-MHz output by 1 dB. R21 may also be used to improve linearity but is usually set for a minimum amplitude variation at the 420-MHz output rather than principally for linearity. Once a symmetrical phase shift is obtained for ±1.57 V input, set R13 for exactly ±90°.

The PB board receives the 70-MHz input from the PA board. This input drives a tripler circuit followed by a two-pole bandpass filter, and a doubler circuit with a resonant output transformer to produce the 420-MHz Output to section N. There are three adjustable capacitors C4, C6 and C11 on the PB board which are peaked for maximum output.

4.3.15 Section N (Figure 6-49).

Section N is an Intermediate Mixer with an output of 500- to 510-MHz. The NA board accepts the 50.000000- to 50.999999-MHz signal from section M and a fixed 420-MHz

signal from section P, and adds them in a plug-in doubly-balanced mixer (IC1) to produce 470.000000 to 470.999999 MHz. This band of frequencies is filtered by a four-pole bandpass filter, amplified, and after passing through a tuned inductor, becomes the output to the NB board.

The NB board adds the 470.000000- to 470.999999-MHz input, from the NA board, to the 30- to 39-MHz INPUT from section ET, in a doubly-balanced plug-in mixer (IC1) to produce 500.000000 to 509.999999 MHz. This signal is amplified and coupled to a five-pole bandpass filter, by a tuned inductor. A special test probe is required to adjust the 4- and 5-pole filters. ***This adjustment should not be attempted in the field.***

Capacitor C6 is used to adjust the NA board for maximum output, with the last 6 frequency dials set to 500000. R5 sets the NA board output for a maximum level. C5 is used to adjust the NB board for maximum output, with the last 7 frequency dials set to 6000000. R5 on the NB board sets the output of this board for a maximum level.

Section N output is fed to section Q.

4.3.16 Section Q (Figure 6-53).

Section Q is an Output Mixer/Amplifier with an output frequency range of 10 kHz to 160 MHz. The QA board receives its 500.000000- to 509.999999-MHz input from section N and its 500- to 350-MHz input from section G. These are subtracted in a double-balanced plug-in mixer (IC1), after the 500- to 510-MHz input is amplified to become a high-level mixer input and the 500- to 350-MHz is attenuated to become the low-level mixer input. The mixer is followed by a two-section, elliptical-function, low-pass filter with a resistive pad at the input to obtain a good mixer termination. The resulting 0 to 159.999999-MHz signal is amplified in an ac-coupled amplifier to produce the desired 0.01- to 159.999999-MHz OUTPUT from the instrument. The first six stages of amplification are carried by the QA board and include a bipolar transistor preamplifier (Q2) driving 2 dual-insulated-gate, FET, variable-gain stages (Q3 and Q4) and a three-stage OUTPUT BUFFER amplifier (Q5, Q6 and Q7) that feeds the QB board.

The filter on the output of Q1 is set for maximum output with capacitor C4. Potentiometer R40 is used to set maximum gain within the harmonic distortion specifications. A rejection filter, on the QA-board output, is peaked by C28, to remove the 505-MHz signal from the synthesized output, with the last 7 dials set to 5000000. This minimizes 500- to 510-MHz spurious signals in the output.

Low frequency cut-off in the amplifier and leveling-detector circuits in section Q limit the lowest usable frequency to 10 kHz. The output level is set with a dc voltage that is compared, in the leveling circuits, to the output of the leveling detector. The difference is used as the error signal for automatic level control circuits to maintain the set level over the entire frequency range of 10 kHz to 159.999999 MHz. Leveling is ahead of a 50 Ω internal resistor to provide an effectively matched source impedance for 50 Ω output cables.

The QB board carries the output Power Amplifier consisting of a single-ended driver and complementary output stage and the output full-wave level detector, detector linearizing dc amplifier, and ALC amplifier.

Potentiometer R21 is used to adjust the differential amplifier (Q4 and Q5) balance. R31 sets the low end of the output voltage level range and R29 sets the high end. R42 sets the Q9 feedback loop to obtain a clean 10-kHz OUTPUT waveform.

4.3.17 Power Supply (Section V Figure 6-65).

The power supply consists of a power transformer (T1), a Rectifier Board (VA), Regulator Board (VB), a Shunt Regulator Board (VC) and three large electrolytic filter capacitors (C1, C2, and C3) all mounted in an assembly with the rear panel. The rear panel forms a heat sink for the transformer and the power transistors associated with the regulator.

The Regulator Board regulates the supplies of −12, +5.6 and +18 V and there are four adjustable potentiometers accessible from the rear of the synthesizer. The 5.6 V and 18 V regulators are referenced to the −12 V regulator, so the latter must be adjusted first. Both coarse and fine adjustments are provided for the −12-V supply. All voltages should be set to within 20 mV by monitoring the outputs at the corresponding test jacks on the rear panel with an accurate voltmeter. An isolating RC filter (C4 and R12) provide +5 V for section C. The shunt-regulator board provides additional filtering and isolation for a +17.8 V supply to section C only.

Separate ground terminals on the three power supplies are connected to a common point on the bottom of the instrument, with separate wires in the main cable, to minimize common impedances. Separate high leads to the various synthesizer sections are used for the same purpose. Ferrite beads are used on all power leads to damp high resonant frequencies.

Service and Maintenance—Section 5

5.1 GR FIELD SERVICE 5-1
5.2 INSTRUMENT RETURN 5-1
5.3 MAJOR COMPONENTS 5-1
5.4 GENERAL MAINTENANCE 5-1
5.5 MINIMUM PERFORMANCE STANDARDS 5-6
5.6 TROUBLE ANALYSIS 5-7
5.7 OUTPUT ADJUSTMENTS 5-8
5.8 AUXILIARY OUTPUTS 5-9

5.1 GR FIELD SERVICE.

Our two-year warranty attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please contact our Service Department (see last page), giving full information of the trouble and of steps taken to remedy it. Be sure to mention the serial, I.D., and type numbers of the instrument.

5.2 INSTRUMENT RETURN.

Before returning an instrument to General Radio for service, please contact our Service Department or nearest District Office, requesting a "Returned Material" number. Use of this number will ensure proper handling and identification. For instruments not covered by the warranty, a purchase order should be forwarded to avoid unnecessary delay.

5.3 MAJOR COMPONENTS.

Figures 5-1 and 5-2 identify the major components of the unit with their corresponding locations.

5.4 GENERAL MAINTENANCE.

5.4.1 Plug-In Etched Boards.

Detailed instructions are included in this manual to isolate a malfunction to a particular etched-circuit board or a group of boards. Because of etched-circuit-board complexity and the difficulty in troubleshooting down to the detail-part level, it is strongly recommended that repairs be handled by replacement of the circuit board. For those who desire to troubleshoot to the detail-part level, information such as voltages and waveforms on the schematic drawings, parts lists, and the circuit description (in the theory section) are supplied.

NOTE

The following boards must be replaced in pairs. A single part number is provided for each pair.

Digit Oscillator Board (EA) Sampler and Divider Board (EB)	P/N 1165-4007
Digit Oscillator Board (EA) Sampler Board (EC)	P/N 1165-4009
Oscillator Circuit Board (GA) Program Board (GB)	P/N 1165-4011

In order to expedite the repair or replacement of the defective etched-circuit board(s) use the following procedure: Contact your nearest General Radio repair facility and supply them with the type, serial number, and identification (I.D.) number of the instrument, the part number of the defective board(s), and a purchase order number. The P.O. number allows for billing, if the unit is out of warranty, and for identification to expedite replacement. The repair facility will arrange for a replacement to be shipped as quickly as possible. Return the defective board(s) in the packing supplied with the replacement(s), or equivalent packing, to prevent further damage to the board(s). Please identify the part, with the "Returned Material" number on the tag furnished with the replacement, and return the defective part to the address on the tag.

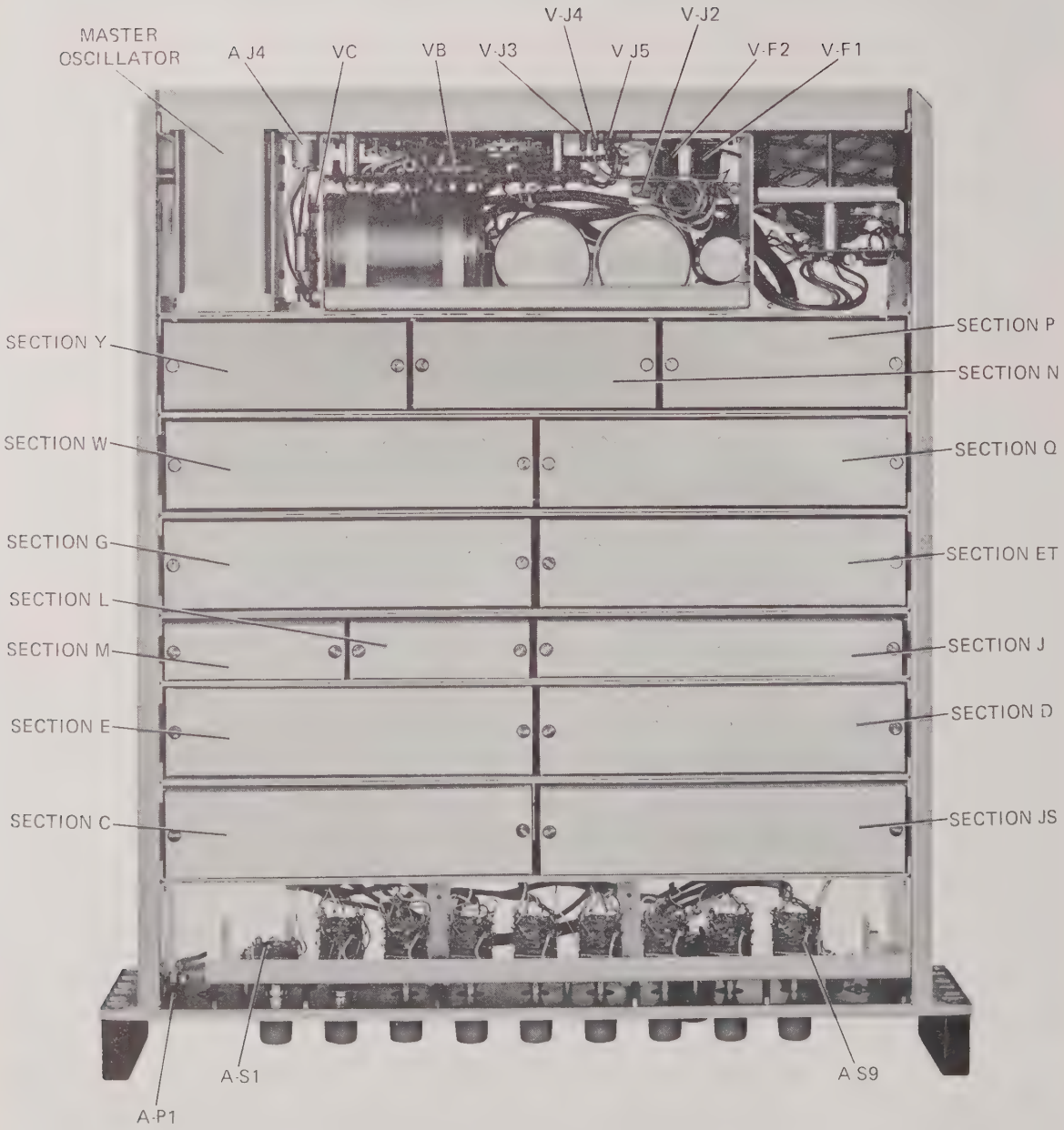


Figure 5-1. Top interior view.

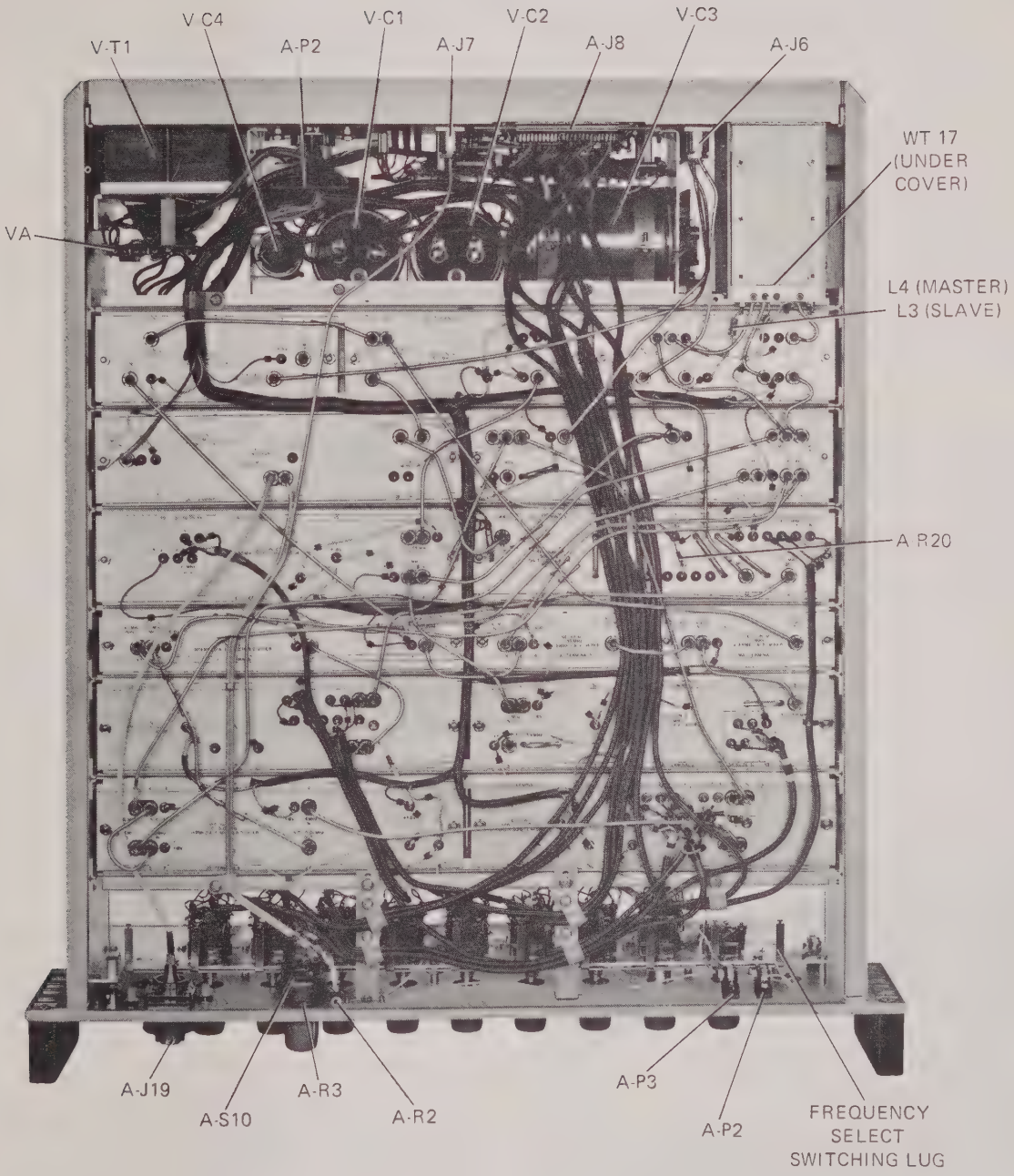


Figure 5-2. Bottom interior view.

5.4.2 Etched-Board Removal/Repair.

In order to isolate a circuit failure in the instrument it will usually be necessary to remove one or more etched-circuit boards to gain access to the internal signal paths. This is done by first removing an enclosure cover by alternately backing off (turning ccw) the two cover screws until the cover is free of its base. The board or boards in that enclosure can then be removed by prying gently in the two holes at the top edge of the board with a small screwdriver or soldering aid.

Since individual boards are more easily tested and adjusted in special test fixtures at the factory, it is recommended that field repair consists of replacement of any defective board with a prealigned one. Prealigned etched-circuit boards can be obtained from the factory or, in most instances, at the nearest General Radio District Office.

5.4.3 Subassembly Removal.

Power Supply (1168-4110). To service the VA Board or power transformer, it may be necessary to remove the complete power-supply assembly. (See Figure 5-3.) Following is a procedure that can be used:

a. Place the instrument top-side-up.

b. Remove the 0.138-32, rear-panel screws that hold the BNC jacks and the BCD FREQUENCY PROGRAM plug in place.

c. Remove the screws 0.190-32 (1) and 0.138-32 (8) that hold the power transformer and rear-panel in place.

d. Lift the instrument and carefully stand it on one side.

e. Remove the 0.138-32 (2) screws and clamp washers from the bottom of the capacitor assembly (near the large capacitors).

f. Unplug the Power-Cable-Connector Board (A-P2).

g. Return the instrument to a horizontal position — place it so that the power supply extends out over the edge of the bench or table on which it rests.

h. Carefully pull the power-supply unit straight away from the rear of the instrument, until the BNC jacks are clear of the rear panel, then lower the unit until it is clear of the instrument.

The power supply can be serviced as it normally functions in the instrument by reconnecting the Power-Cable-Connector board.

CAUTION

Do not operate the power supply with the Power-Cable-Connector board removed, since a residual charge in the filter capacitors can damage the regulator circuits when the board is replaced.

Master Oscillator Unit. The master oscillator (section X) can be removed by the following procedure:

a. Remove the bottom cover.

b. Unsolder the leads to the terminals thus exposed.

c. Loosen the clamp screws at the bottom forward edge of the unit.

d. Remove the single mounting screw through the left side frame of the instrument and remove the unit.

NOTE

The External Drive Input Unit (slave synthesizer) can be removed by the same procedure.

Front-Panel Circuits. Better access to the circuits associated with the front-panel controls can be gained by the following procedure:

a. Remove the nuts that secure the side frames to the front panel.

b. Carefully tilt the front-panel in a direction that will allow access to the necessary component.

Figure 5-3. Power-supply unit disassembled.

5.4.4 Knob and Bushing Removal.

To remove the front-panel control knobs and bushings, either to replace one that has been damaged or to replace the associated control, proceed as follows:

a. Grasp the knobs firmly with the fingers close to the panel and pull straight away from the panel.

b. Remove the handles from the front-panel by backing off the four 10/32 screws, two for each handle.

c. Remove the GR874 output connector by backing off the knurled ring and pulling the connector out of the panel from the rear.

d. Loosen the FREQUENCY SELECT locking screw and remove the slotted control.

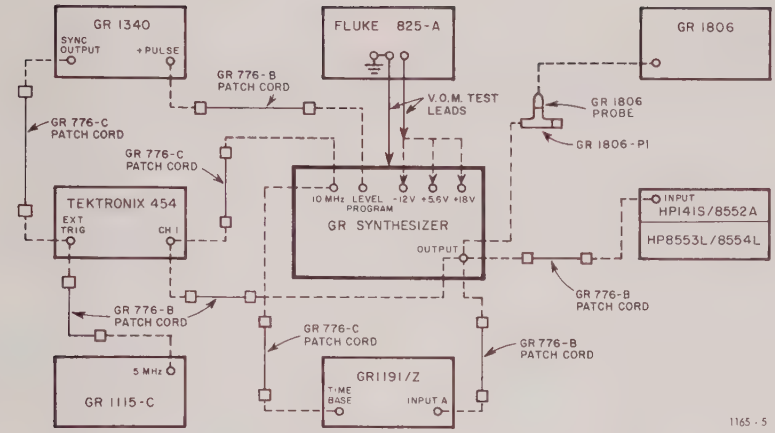


Figure 5-4. Test Setup.

e. Remove the four 5/16-in. nuts that hold the dress panel in place. Set the frequency switches to the zero position and remove the dress panel without moving the dial.

f. Use a 3/16-in. Allen wrench to release the setscrew and pull the bushing off of the shaft. The dial, marked with numerals 0 through 9 for frequency indication, is fixed to the bushing and will be removed with it.

When the front panel is removed, note that the frequency dials overlap and two different size bushings are used. Be sure to replace the dial assemblies in the same order that they were removed.

5.4.5 Knob and Bushing Installation.

To install a knob and bushing assembly proceed as follows:

a. Mount the dial and bushing assembly on the switch shaft, in proper relative position noted above, but do not tighten the setscrew.

b. Replace the dress panel and secure in place.

c. Pull the dial forward and center the zero in the dress-panel window.

d. Tighten the setscrew and check to see that the bushing does not bind when rotated.

e. Reverse steps b, c, and d of paragraph 5.4.4.

f. Place the knob on the bushing with the retention spring opposite the setscrew.

g. Push the knob in until it bottoms; pull it slightly to check that the retention spring is seated.

5.4.6 Frequency-Switch Removal.

To remove a switch assembly proceed as follows:

a. Set the switch to zero.

b. Remove the knob and loosen the bushing setscrew.

c. Unsolder the black wire connected to the frequency switch mounting bracket and any wires connected to the adjacent switches. Label the wires as they are removed so that they can be identified for reassembly.

d. Loosen the ½-in. nut that holds the switch in place. (To remove (A-S1 or A-S2) the interlock mechanism setscrews will have to be loosened. Observe the orientation of the mechanism as part of it will come free when either of these switches are removed.)

e. Disengage the frequency select switch lug from the metal bar connected to the third switch wafer from the front panel.

f. Pull the switch out of the panel from the rear. If the switch is to be replaced, it is suggested that the wire connections be transferred from the original to the replacement, one at a time, to insure proper connections.

5.4.7 Frequency-Switch Installation.

To install a switch assembly proceed as follows:

a. Insert the switch, shaft-end first, through the switch--mounting bracket, ½-in. lockwasher and nut, interlock mechanism (if present) and then through the front panel and bushing assembly.

b. Observe that the outboard end of the shaft has a flat side, (except A-S1). Set the switch to 0 by rotating the shaft so that the flat side is up. (Set A-S1 at ccw stop.) Tighten the ½-in. nut.

c. Rotate the dial assembly so that "0" is centered in the front-panel window; pull forward until the teflon washer (not visible) is bearing lightly against the inner surface of the dress panel.

d. Tighten the bushing setscrew securely to the switch shaft.

e. Replace the knob as directed in para. 5.4.5 steps d and e.

f. Solder the ground wire, and any wires removed from the original switch, to the proper terminals of the replacement switch.

5.4.8 IC Removal/Installation.

Socket Mounted. IC's that are mounted in sockets can be removed by insertion of a small-bladed screwdriver under the end of the IC and gently prying the IC up out of its socket.

When installing an IC in a socket, put all the leads from one side of the IC in the socket first and push the IC to that side until the leads on the other side line up with their socket holes. Push these leads into the socket and release the IC.

Board Mounted. An IC can be removed from an etched-circuit board with a soldering iron and a solder sucker (such as a Soldapulit*). Clean the solder from each pin on the IC and remove the IC from the board.

Insert the new IC in the holes left by the old one, and solder each pin. Be careful not to burn the etched-circuit board.

5.5 MINIMUM PERFORMANCE STANDARDS.

5.5.1 General.

Perform all checks in para. 3.4 to establish that the unit (master and slave versions) meets minimum performance standards. The following additional checks may also be used. Refer to para. 5.6 if unable to obtain the performance called for in the minimum performance procedure.

5.5.2 Test Equipment.

The equipment listed in table 5-1 is recommended for the ensuing tests. Figure 5-4 shows a test setup using this equipment.

5.5.3 Output Frequency Range.

The Proper Frequency Generation check (para. 3.4.2) offers a convenient procedure to verify generation of proper frequencies. Connect equipment as shown in Figure 5.4 and make additional checks as follows:

*Registered trademark of Edsyn, Inc., 15954 Arminta St., Van Nuys, California, 91406.

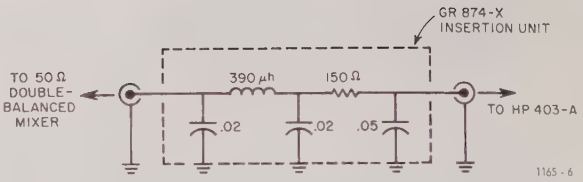


Figure 5-5. Low-pass filter (15 kHz).

a. Connect the output of the unit to the 1191/Z counter. Use the GR 776-B patch cord.

b. Connect the counter rear-panel TIME BASE connector to the synthesizer rear-panel 10 MHz OUT connector. This locks the counter time base to the master oscillator. Use the GR 776-C patch cord.

c. Set the X10-kHz dial to "1" and the other dials to "0".

d. Set the counter to measure frequency with a 1 sec counting time. The counter should indicate 10 kHz ±1 count.

e. Advance the X 1 Hz dial through each step from "0" to "9". Notice that the counter indication increases by 1 count with each step.

f. Repeat the observations at step-digit settings for the X10 Hz, X100 Hz, X1 kHz, X10 kHz, X100 kHz, X1 MHz, and X10 MHz dials and observe the counter indication.

The above checks serve the primary function of assuring that the signal paths from the digit oscillators to the output section are functioning properly, over the entire frequency range.

5.5.4 Output Amplitude.

The amplitude variations, from the lowest indication to the highest, must be less than 1 dB from 10 to 100 kHz and less than 0.6 dB from 100 kHz to 160 MHz.

Use the following procedure to check the output amplitude response:

a. Set the synthesizer output frequency to 80 MHz.

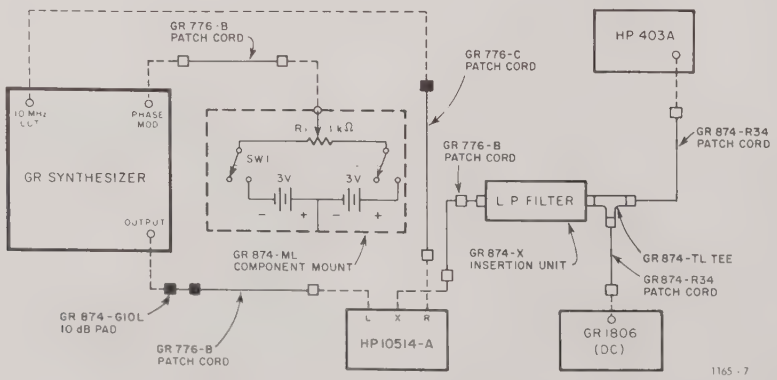


Figure 5-6. Phase- and amplitude-noise modulation measurement setup.

b. Connect the 1806-P1 Probe and the GR874-W50BL 50 Ω termination to the 1806-P1 Tee.

c. Connect the GR 1806-P1 Tee and 1806 P1 probe to the OUTPUT connector of the synthesizer.

d. Adjust the synthesizer OUTPUT LEVEL control for an indication of 1.0 V on the 1806 Voltmeter.

e. Vary the synthesizer output frequency from 10 kHz to 160 MHz and note that the response, as indicated by the 1806 Voltmeter, varies as indicated above.

5.5.5 Spurious Frequency Outputs.

Connect a spectrum analyzer to the OUTPUT connector of the synthesizer.

a. Set the synthesizer dials to the desired frequency and adjust the OUTPUT level control for maximum output.

b. Check the analyzer for nonharmonic and harmonic spurious signals. Harmonic (at maximum output with 50 Ω load): 0.01 to 0.1 MHz <25 dB; 0.1 to 160 MHz < 30 dB. Discrete nonharmonic: 0.01 to 110 MHz < 60 dB (−70 dB typical); 110 to 160 MHz < 55 dB, (−60 dB typical).

5.5.6 Phase and Amplitude Noise Modulation.

Phase-noise modulation is not critically dependent on the output frequency. It can be measured by using the rear-panel 10 MHz OUT signal to check the synthesized output at 10 MHz. Figure 5-6 shows the recommended setup for measuring both phase and amplitude noise modulation of the synthesizer OUTPUT. The HP 10514-A Double-Balanced Mixer output must be fed through a 15-kHz low-pass filter (Figure 5-5) to comply with specifications. The shielded ±3-V battery and potentiometer, feeding the rear-panel PHASE MOD input, permits relative phase adjustment of the output and reference sources. The noise meter must have sufficient sensitivity to measure at least 60 dB down from the calibrate level, which is approximately 250 mV in the setup shown.

For minimum effects from stray capacitance and magnetic fields, the filter circuit (Figure 5-5) and the battery-potentiometer circuit (shown in Figure 5-6) should be mounted in shielded enclosures. The GR 874-X Insertion Unit (P/N 0874-9990) is recommended as a convenient mounting device for the former and the GR 874-ML Component Mount (P/N 0874-9663) is suitable for the latter. Mount the 1-kΩ potentiometer (R1) inside the component mount so that the adjustment screw aligns with one of the holes in the mount cover. The J. F. D. ADJUSTMENT TOOL number 5284, is a convenient tool for adjusting R1.

Make the connections as shown in Figure 5-6. To calibrate the phase- and amplitude-noise modulation measuring system, set the frequency dials to read 10,001,000 Hz and adjust the OUTPUT level control to produce a convenient reference indication on the noise meter, such as −10 dB.

To measure the Phase-Noise Modulation follow this procedure:

a. Set the frequency dials to 10,000,000 Hz.

b. Set SW1 (Figure 5-6) to the closed position.

NOTE

Set SW1 to the off position when not in use.

c. Adjust R1 (Figure 5-6) for 0-V dc out of the mixer.

d. Increase the noise-meter sensitivity until an indication of phase-noise modulation is obtained. It should be at least −53 dB, re 1 radian.

To measure the Amplitude-Noise Modulation follow this procedure:

a. Perform the calibration procedure above.

b. Set the frequency dials to 10,000,000 Hz.

c. Set SW1 (Figure 5-6) to the closed position.

d. Adjust the battery potentiometer for maximum dc out of the mixer.

e. Remove the 1806 — this eliminates possible effects on the amplitude-noise modulation measurement.

f. Observe the amplitude-noise modulation on the noise meter to be at least −63 dB, re 100% carrier.

5.6 TROUBLE ANALYSIS.

5.6.1 General.

Sectional construction of the unit simplifies trouble analysis and repair. Most circuits are divided, both functionally and physically, among twenty-five plug-in etched-circuit boards. Three of them plug into single-board shielded enclosures; twenty-two of them plug into double-board shielded enclosures, which are internally divided into two compartments. Each enclosure cover is forced on or off with two captive screws, providing easy access to the etched boards. Trouble analysis to the etched board level only is recommended.

The bottom cover of each section is clearly marked with the section function, section designator, terminal numbers, power supply voltages, and input and output frequencies. A detailed block diagram (Figure 6-3) provides nominal currents, power-supply voltages, signal frequencies and signal levels. These two sources of information should be used in conjunction with the schematic diagrams as an aid for locating a malfunction.

The 50-Ω load termination, specified for many of the signal levels, is not mandatory for general signal tracing with a high-impedance probe. However, a 50-Ω load must be provided where specified for final testing or calibration.

Performance of the tests described in para. 5.5 will in many cases suggest to a user, thoroughly familiar with synthesizer operation, where a malfunction is originating. If no output signal is present, it is necessary to perform other tests to locate the problem. A logical starting point is the power supply.

5.6.2 Trouble Analysis Procedure.

If the synthesizer output is abnormal or if no output is present, use the following procedures (in the order presented) to isolate the problem.

Power Supply. Three rear-panel pin jacks provide a means of checking power supply voltages. If any of them are absent, first check the wiring between the rear-panel socket and the power supply. Once a malfunction is isolated to the power supply, systematically check the levels listed on Figure 6-65.

A component replacement, in most cases, will not require readjustment of the supplies. However, an adjustment procedure is included for use where necessary.

Use the following procedure to check or adjust the power supply voltages:

NOTE

Do not adjust these voltages unless absolutely necessary.

a. Use the John Fluke Differential DC Voltmeter Model 825A or equivalent. Set the controls as follows:

RANGE control	– – – 50
Null control	– – – 0.1
Input control	– – – (–)
A-E controls	– – – 12.000

b. Connect the –12 V pin jack to the differential dc voltmeter input. Use a multimeter test lead and insert the probe into the pin jack.

c. Connect the synthesizer chassis to the differential voltmeter ground terminal. The ground terminal shorting bar should be connected to the low input terminal.

d. Check or adjust the –12 V supply to be within 0.02 V as indicated by the Fluke 825-A. Coarse and fine controls are provided for ease of setting.

NOTE

Step d must be executed before step e.

e. Repeat step d for the +5.6 ±.02 V and +18 ±.02 V supplies.

Master Oscillator. Connect the 454 scope to the rear-panel 10-MHz jack. This signal comes from the master oscillator unit via an amplifier in section Y. If no signal is present at the rear-panel jack, bypass the amplifier by removing the unit from its cabinet and connecting the scope to WT17. (Remove the master oscillator bottom cover to gain access to WT17.) Frequency accuracy is not important at this point. Look for the absence (or presence) of the signal, or for a frequency that is significantly different from 10 MHz.

For a slave-version synthesizer, check the output signal of the drive source.

Other Modules. With no clue to the problem at this juncture, an assumption can be made that the malfunction is in one of the other modules. A recommended procedure is to check the outputs and inputs of each module starting with section Q and working back toward the digit oscillators. Use the 1806 electronic voltmeter, with an ac probe and a short ground lead, to measure the levels; use the 454 scope with the P6047 probe to measure frequency up to 150 MHz. Above this frequency use the 1191/Z or a scope with a higher frequency limit.

Figure 6-3 lists the levels as dBm into a 50-Ω load, however, for convenience the termination can be eliminated when troubleshooting. This will allow the measurements to vary as much as 3 to 1, but the detection of the presence or absence of a level is all that is necessary to isolate the problem to a particular board.

The output and input frequencies should be as specified on the block diagram for each section. It may be necessary to set the X100- and X10-MHz frequency dials to the positions that will provide the highest input levels to section Q, in order to trigger the counter. This is necessary for section Q only.

For example: If there is no output from the unit, check to see that the power supply is providing the correct voltages and the master oscillator the correct frequency. Remove the cover from Section Q and remove board QA; check the level and frequency at QA3 and QA6. If a voltage level and the correct frequency are present at QA3, but there is no input to QA6, check the reference input to section G (GB36). If the reference signal is correct, refer to Figure 6-41 and check the signals between boards to isolate the problem to Board GA or GB. If the reference signal is incorrect, refer to Figure 6-16 and isolate the problem to board WA or WB. Use the same general procedure to isolate other malfunctions.

NOTE

Matched boards are used in sections E, ET and G. If a board from any of these sections has to be returned for repair, return both boards for the particular section involved. Refer to para. 5.4.1 and/or the parts list for part numbers.

5.7 OUTPUT ADJUSTMENTS.

5.7.1 General.

The trouble analysis procedure could result in the replacement of one or more etched-circuit boards. If that is the case, the adjustment procedures presented in this para. should be checked to insure proper operation.

5.7.2 Master Oscillator Frequency.

The master oscillator must be adjusted periodically, to correct for normal crystal aging. A rear-panel screwdriver adjustment is provided for that purpose.

NOTE

Before attempting to make this adjustment, allow the master oscillator to operate for a minimum of two hours.

Use the following procedure to adjust the master-oscillator frequency:

a. Connect the 1115-C 5-MHz output to the Tektronix Model 454 oscilloscope EXT TRIG. Use the GR 776-B patch cord.

b. Set the scope controls as follows:

"A" TRIGGER (source) — — EXT
TIME/DIV — — — — — — — 0.05 μs
MODE TRIGGER — — — — CH1
HORIZ DISPLAY (mag) — — X10
"A" SWEEP LENGTH — — — FULL
VOLTS/DIV (CH1) — — — — 1 V

c. Set the frequency dials to 100,000,000 Hz.

d. Set the OUTPUT control to 1 V.

e. Connect the OUTPUT to the scope CH1 INPUT.

f. A 100-MHz sinewave pattern will appear on the CRT and two divisions of the graticule will represent one complete cycle. Using an insulated screwdriver (such as the GC 8290)* adjust the master-oscillator frequency control until the sinewave pattern stops moving or slows to a rate of less than 2 div/sec. The master oscillator frequency is now set to an accuracy $\geqslant 1 \times 10^{-8}$.

5.7.3 Phase-Detector Balance.

Perform steps a through f of para. 5.7.2 and then use the following procedure to adjust the phase detector balance:

a. Depress the rear-panel lock-fail switch. If the phase detector is out of balance, the sinewave pattern will move faster across the scope.

b. Adjust R22 until the pattern is stationary or moves across the CRT at a rate less than 2 divisions/sec.

c. Release the lock-fail switch and again observe the scope pattern. Readjust the master oscillator, if necessary.

Repeat this procedure until the scope pattern for both the master-oscillator frequency and phase-detector balance remains stationary or sweeps at a maximum rate of 2 div/sec.

5.7.4 Output Level Control.

Use the following procedure to calibrate the OUTPUT level control:

a. Refer to para. 5.5.4 and perform steps a-d.

b. Adjust R2 for 1 V. R2 is located behind the front panel and is in series with the output potentiometer.

c. Check the 0.5 and 0.2 V positions of the output control to be within ±2 dB. If any of these output control settings exceed specifications, remove the control knob and slip the bushing to compensate for the descrepancy. Replace the knob and recheck the same positions.

d. Set the output control to the 1-V position. Vary the synthesizer output frequency from 10 kHz to 160 MHz and observe the response as indicated by the voltmeter. Variations from the lowest indication to the highest must be less than 1 dB from 10 to 100 kHz and less than 0.6 dB from 100 kHz to 160 MHz.

5.7.5 Level Programming Stability.

Use the following procedure to adjust the programmed level stability:

a. Set the frequency dials to 9 kHz.

b. Set the OUTPUT control to the REMOTE position (fully ccw).

c. Set the GR Type 1340 Pulse Generator controls as follows:

PULSE DURATION — — — Square Wave (30 MHz)
PULSE OFFSET — — — — — +1 V
PULSE AMPLITUDE — — — 3 V p. to p.

d. Connect the OUTPUT to the CH1 INPUT of the oscilloscope.

e. Connect the 1340 SYNC OUTPUT to the scope EXT TRIG INPUT. Use the GR 776-C patch cord.

f. Connect the 1340 +PULSE output to the 1168 LEVEL PROGRAM jack. Use the GR 776-B patch cord.

g. Remove the top cover from section Q.

h. Observe the oscilloscope pattern and adjust R42 (QB board) for minimum ringing and overshoot. Rise and fall time should be 90% complete within 10 ms.

5.8 AUXILIARY OUTPUTS.

Two auxiliary fixed-frequency outputs are available from separate rear-panel BNC jacks. One is a 1-MHz square-wave signal of 2-V pk-pk, into 10-kΩ; the other is a 10-MHz sinusoid signal of 0.5 ±0.05 V rms, into 50 Ω.

The rear-panel power supply test points can also be used as auxiliary voltage outputs.

*General Cement or equivalent.

Table 5-1
TEST EQUIPMENT

Function	Recommended Type or Model*	Performance Characteristics
Electronic Voltmeter (VTVM)	GR 1806 (with 1806-P1)	1.5 - 1500 V full scale, ±2% accuracy
AC Voltmeter	HP 403-A	100 μV - 300 V, dB range - 60 to 50 dB
Dc Differential Voltmeter	John Fluke 825-A	0-500 V accuracy ±0.02% +25 μV below 0.1 V
VOM	Triplet 630 NA	Dc accuracy ±2%
Metered Variac®	GRW5MT3W	300 W/150 V, full scale, meters
Oscilloscope	Tektronix† 454	Dc to 150 MHz
Counter with Scaler	GR 1191/Z	Dc to 500 MHz
Spectrum Analyzer	HP 141S/8552A 8553L/8554L	1 kHz - 1.2 GHz
Double Balanced Mixer	HP 10514-A	"L" and "R" ports: 200 kHz to 500 MHz "X" port: dc to 500 MHz
Frequency Standard	GR 1115-C	Output Frequencies: 5 MHz, 1 MHz, and 100 kHz
Pulse Generator	GR 1340	0.2 Hz to 20 MHz; 2.5 s to 25 ns duration.
Patch cord	GR 766-C (2)	BNC plug to BNC, 3 ft.
Patch cord	GR 776-B (2)	GR 874 to BNC, 3 ft.
Patch cord	GR 874-R34	GR874 connectors, 3 ft.
Coaxial Tee	GR 874-TL	Locking version
Coaxial Load	GR W50BL	50 Ω ±0.5%
Coaxial Pad	GR 874-G10L	50 Ω 10 ±0.15 dB
Insertion Unit	GR 874-X	2 in. long, 9/16-in. dia.
Component Mount	GR 874-ML	2 5/8-in. long, 3-in. dia.

*Or equivalent

†Reg. trademark, Tektronix Inc., Beaverton, Ore.

Parts Lists and Diagrams—Section 6

Item	Page
MECHANICAL PARTS	6-3
BLOCK DIAGRAM	6-3
PANEL CIRCUIT SCHEMATIC	6-4
SECTIONS X AND Z SCHEMATIC DIAGRAMS	6-5
SECTION Y SCHEMATIC DIAGRAM	6-7
SECTION W SCHEMATIC DIAGRAM	6-9
SECTION C SCHEMATIC DIAGRAM	6-11
SECTION J SCHEMATIC DIAGRAM	6-13
SECTION L SCHEMATIC DIAGRAM	6-15
SECTION E SCHEMATIC DIAGRAM	6-17
SECTION M SCHEMATIC DIAGRAM	6-19
SECTION ET SCHEMATIC DIAGRAM	6-21
SECTION G SCHEMATIC DIAGRAM	6-23
SECTION P SCHEMATIC DIAGRAM	6-25
SECTION N SCHEMATIC DIAGRAM	6-27
SECTION Q SCHEMATIC DIAGRAMS	6-29
SECTION JS SCHEMATIC DIAGRAMS	6-31
SECTION D SCHEMATIC DIAGRAMS	6-33
POWER SUPPLY SCHEMATIC DIAGRAM	6-35

NOTE

Each reference designator used in our schematic diagrams and circuit descriptions includes an initial letter, before a hyphen, to identify the subassembly (except that A refers to the main frame). The numeric portion of each designator is generally shorter than would be the case if a block of numbers were assigned to each subassembly. A new designation WT (wire-tie point) replaces the customary AT (anchor terminal). The letter before the hyphen may be omitted only if clearly understood, as within a subassembly schematic diagram.

Examples: B-R8 designates B board, resistor 8; D-WT2 = D board, wire-tie point 2; CR6 on the V schematic is a shortened form of V-CR6 = V board, diode 6. The instrument may contain A-R1, B-R1, C-R1, and D-R1.

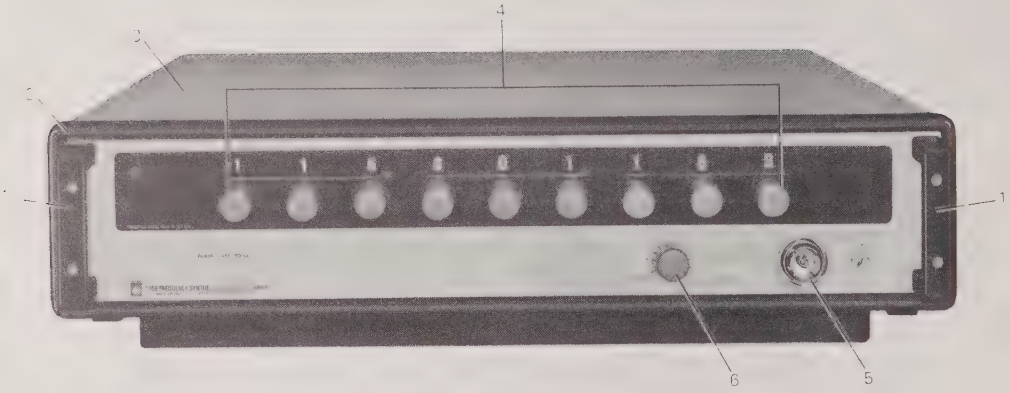


Figure 6-1. 1168 mechanical parts, front view.

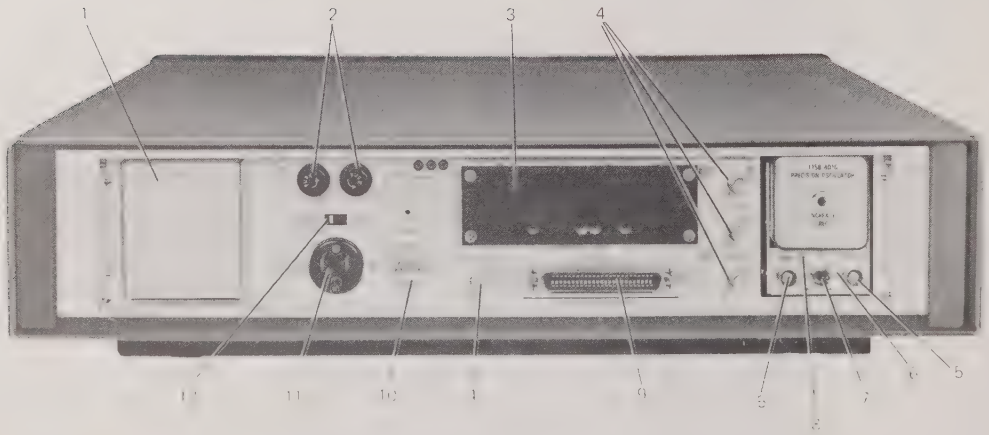


Figure 6-2. 1168 mechanical parts, rear view.

MECHANICAL PARTS LIST

Qnt	Fig Ref	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
FRONT PANEL						
2	1	Handle	5360-2007	24655	5360-2007	
1	2	Cabinet gasket	5331-2156	24655	5331-2156	
1	3	Cabinet asm., tilted, includes:	4173-4008	24655	4173-4008	
2		Foot, extruded, block neoprene	4171-7020	24655	4171-7020	
1		Foot asm. for tilt base:	4171-1012	24655	4171-1012	
1		Foot	4171-8012	24655	4171-8012	
2		Knobs	5540-3313	24655	5540-3313	
1		Gasket	5331-2156	24655	5331-2156	
9	4	Knob asm., FREQUENCY RANGE, including retainer 5220-5402	5520-5220	24655	5520-5220	
1	5	Output cable asm., A-J9	1168-0265	24655	1168-0265	
1	6	Knob asm., REMOTE/0.5/1 VOLT ACROSS 50 Ω, including retainer 5220-5402	5520-5221	24655	5520-5221	
		NOTE: The Slave Unit Synthesizer will have a toggle switch in place of the EXT LOCK FAIL lampholder.				
1		Toggle switch, S9, POWER ON	7910-0791	95146	MST-205N	

*Master Unit Only

REAR PANEL						
1	1	Cover	1165-8281	24655	1165-8281	
2	2	Fuse mounting device	5650-0100	71400	HKP-H	5920-284-7144
1	3	Cover	1168-8250	24655	1168-8250	
4	4	Multiple sockets: A-J4, PHASE MOD; A-J5, 1 MHz OUT; A-J6; 10 MHz OUT; A-J7, LEVEL PROGRAM	4230-2350	02660	31-300	
2	5	*Multiple socket, X-J1, 5 MHz/n/ LOCK; X-J3, 10 MHz/DRIVE	4230-2301	09408	UG-1094/U	
1	6	*Plunger	1165-6145	24655	1165-6145	
1	7	*Toggle switch, X-S1	7910-0791	95145	MST-205N	
1	8	*Multiple plug, X-J2	4270-0900	98291	SKT-1	
1	9	Multiple socket, A-J3, BCD FREQUENCY PROGRAM	4230-4049	93916	57-40500	5935-062-1776
1	10	Panel filler, OUTPUT ON OPPOSITE FACE	1165-6160	24655	1165-6160	
1	11	Power plug, V-J1	4240-0700	24655	4240-0700	5935-794-3012
1	12	Slide switch, V-S1, LINE VOLTAGE SELECTOR	7910-0832	82389	11A-1118	
		NOTE: The Slave Unit Synthesizer has an External Drive Input Unit (1165-4130) in place of the Master Oscillator Unit (1165-4125)				
1	Slide	Slide switch, Z-S1 INPUT	7910-0832	82389	11A-1118	
1		Multiple socket, Z-J1 INPUT	4230-2301	09408	UG-1094A/U	

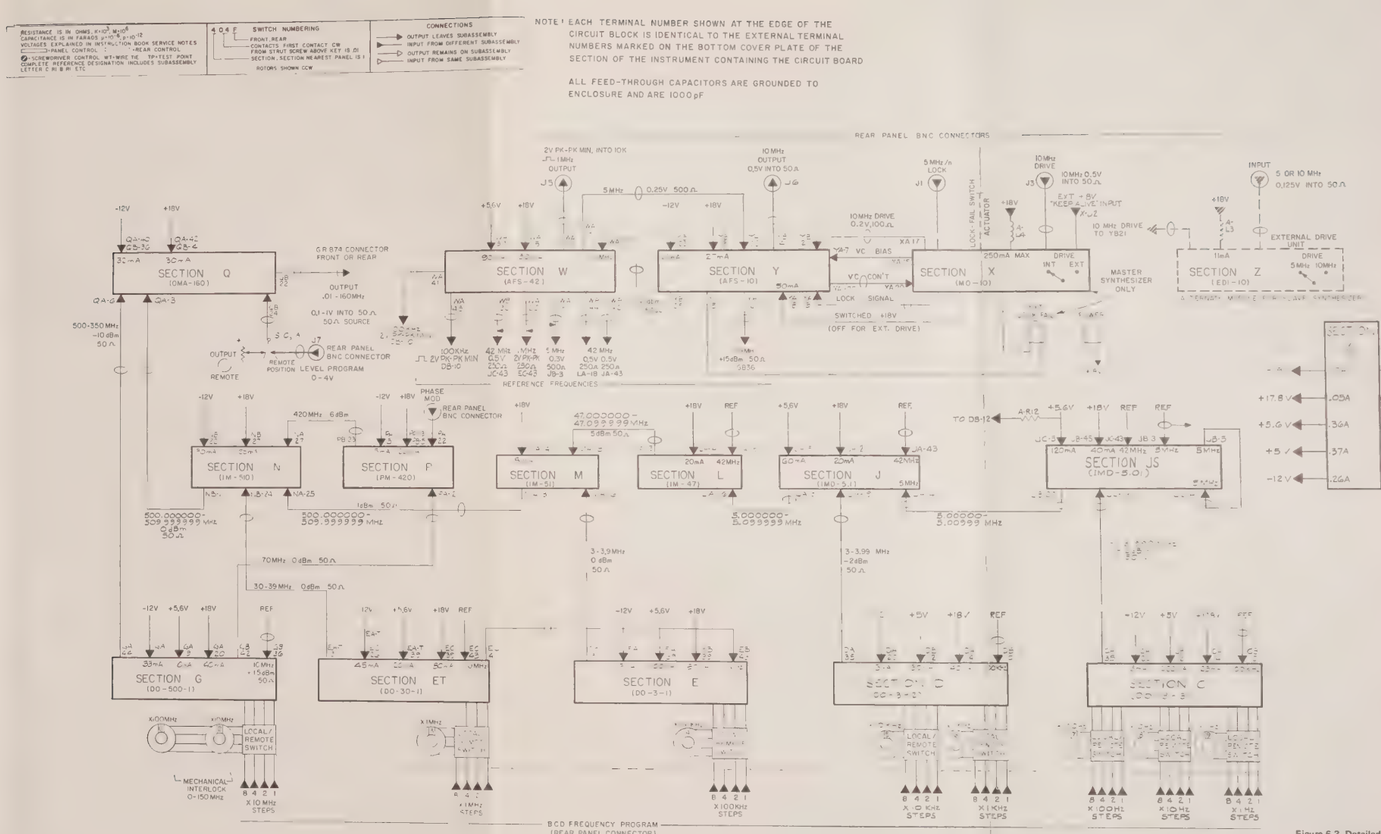

RESISTANCE IS IN OHMS, K=10³, M=10⁶
CAPACITANCE IS IN FARADS; μ=10⁻⁶, p=10⁻¹²
VOLTAGES EXPLAINED IN INSTRUCTION BOOK SERVICE NOTES
—○— PANEL CONTROL
SCREWDRIVER CONTROL, WT=WIRE TIE, TP=TEST POINT
COMPLETE REFERENCE DESIGNATION INCLUDES SUBASSEMBLY LETTER C or B or T etc.
4 0 4 F
SWITCH NUMBERING
FRONT-REAR
CONTACTS, FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY IS .01
SECTION, SECTION NEAREST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY
NOTE: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD
ALL FEED-THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF
REAR PANEL BNC CONNECTORS
SECTION Q (0MA-160)
SECTION W (AFS-42)
SECTION Y (AFS-10)
SECTION X (MO-10)
SECTION Z (EDI-10)
SECTION N (1M-510)
SECTION P (1PM-420)
SECTION M (1M-511)
SECTION L (1M-47)
SECTION J (1MD-5.1)
SECTION JS (1MD-5.0)
SECTION G (00-500-1)
SECTION ET (00-30-1)
SECTION E (00-3-1)
SECTION D (00-3-2)
SECTION C (00-3-3)
REFERENCE FREQUENCIES
BCD FREQUENCY PROGRAM (REAR PANEL CONNECTOR)
MASTER SYNTHESIZER ONLY
EXTERNAL DRIVE UNIT
POWER SWITCH SLAVE ONLY
100 TO 125V OR 200 TO 250V
50 TO 60 HZ 180 TO 400 HZ ABOVE 105/210V
45W MAX

Figure 6-3. Detailed block diagram.

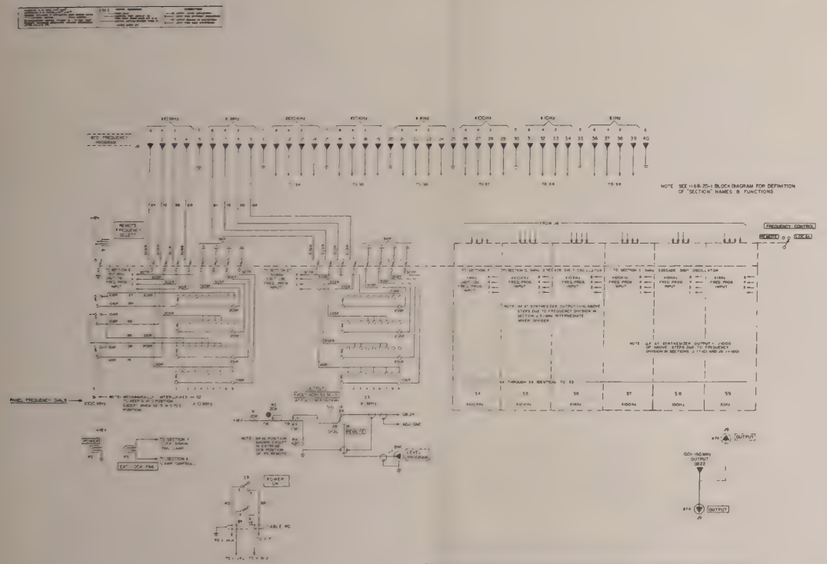


Figure 6-4. Panel circuit schematic for both master and slave version synthesizers.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1168-4115 FRONT PANEL ASM MASTER (160 MHz x 100 Hz) (A)					
RESISTORS					
R1	Comp. 20 kΩ ±5% .25 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R2	Pot. Comp. 20 kΩ ±10%	6049-0299	01121	ZH2031	
R3	Pot. Comp. 10 kΩ ±10%	6045-0400	01121	TT, 10 kΩ ±10%	
R4	Comp. 620 Ω ±5% .25 W	6099-1625	75042	BTS, 620 Ω ±5%	5905-801-6998
PILOT LAMPS					
P1	Pilot Lights 28 V	5600-1060	24655	5600-1060	
P2	Pilot Lights 28 V	5600-1060	24655	5600-1060	
P3	Pilot Lights 28 V	5600-1060	24655	5600-1060	
1168-4116 FRONT PANEL ASM SLAVE (160 MHz x 100 Hz) (A)					
RESISTORS					
R1	Comp. 20 kΩ ±5% .25 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R4	Comp. 620 Ω ±5% .25 W	6099-1625	75042	BTS, 620 Ω ±5%	5905-801-6998
POTENTIOMETERS					
R2	Pot. Comp. 20 kΩ ±10%	6049-0299	01121	ZH2031	
R3	Pot. Comp. 10 kΩ ±10%	Part of 6045-0400	24655	6045-0400	
SWITCH					
S11	Toggle, DPDT	7910-0791	95146	MST-20SN	
S10	Toggle, DPDT	Part of 6045-0400	24655	6045-0400	
PILOT LAMPS					
P1	Pilot Lights 28 V	5600-1060	24655	5600-1060	
P2	Pilot Lights 28 V	5600-1060	24655	5600-1060	
1168-4120 SWITCH PANEL ASM (9 DIALS - 159999999)					
SWITCHES					
S1	Rotary wafer	7890-5326	24655	7890-5326	
S2	Rotary wafer	1165-2324	24655	1165-2324	
S3	Rotary wafer	1165-2325	24655	1165-2325	
S4	Rotary wafer	1165-2325	24655	1165-2325	
S5	Rotary wafer	1165-2325	24655	1165-2325	
S6	Rotary wafer	1165-2325	24655	1165-2325	
S7	Rotary wafer	1165-2325	24655	1165-2325	
S8	Rotary wafer	1165-2325	24655	1165-2325	
S9	Rotary wafer	1165-2325	24655	1165-2325	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4060 INPUT BOARD (XA)					
CAPACITORS					
C1	Ceramic, .01 μF +80-20% 50 V	4401-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C2	Ceramic, 1.0 μF ±20% 25 V	4400-2070	80183	SC13, 1 μF ±20%	5910-083-6445
C3	Ceramic, .01 μF +80-20% 50 V	4401-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C4	Ceramic, .01 μF +80-20% 50 V	4401-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C5	Ceramic, .01 μF +80-20% 50 V	4401-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
RESISTORS					
R1	Pot. Comp. 500 Ω ±30%	6049-0105	98474	62TR500	
R2	Comp. 100 Ω ±5% .25 W	6099-1105	75042	BTS, 100 Ω ±5%	
R3	Comp. 51 Ω ±5% .25 W	6099-0515	75042	BTS, 51 Ω ±5%	
R4	Comp. 820 Ω ±5% .25 W	6099-1825	75042	BTS, 1 kΩ ±5%	5905-681-6462
R5	Comp. 6.8 kΩ ±5% .25 W	6099-2685	75042	BTS, 6.8 kΩ ±5%	5905-686-9997
R6	Film 1.0 kΩ ±1% .25 W	6250-1100	75042	CEB, 1 kΩ 1%	5905-581-6915
R7	Comp. 100 Ω ±5% .25 W	6099-1105	75042	BTS, 100 Ω ±5%	
R8	Comp. 10 kΩ ±5% .25 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R9	Comp. 150 kΩ ±5% .25	6099-1155	75042	BTS, 150 Ω ±5%	5905-683-2243
R10	Comp. 10 kΩ ±5% .25	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R11	Comp. 470 Ω ±5% .25 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R12	Comp. 100 Ω ±5% .25 W	6099-1105	75042	BTS, 100 Ω ±5%	
R13	Comp. 33 Ω ±5% .25 W	6099-0335	75042	BTS, 33 Ω ±5%	
R14	Comp. 10 kΩ ±5%	6098-3105	01121	BB, 10 kΩ ±5%	
R15	Film, 7.87 kΩ ±1%	6250-1787	75042	CEA, 7.87 kΩ ±1%	
R16	Comp. 100 kΩ ±5%	6098-4105	01121	BB, 100 kΩ ±5%	
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N4861	8210-1221	96214	2N4861	
FILTER					
FL1		5284-1000	82567	#F13138	
DIODE					
CR1 and CR2	Type 1N645	6082-1016	24446	1N645	5961-087-6047
CR3	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
1165-4125 MASTER OSCILLATOR UNIT (X)					
JACKS					
J1	Multiple Socket	4230-2301	09408	UG-1094A/U	
J2	Signal Plug	4270-0900	98291	SKT-1	
J3	Multiple Socket	4230-2301	09408	UG-1094A-U	
SWITCH					
S1	Toggle	7910-0791	95146	MST-20SN	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4065 INPUT FILTER BOARD (ZA)					
RESISTORS					
R1	Thermistor, 200 Ω ±10%	6740-1600	02606	KB22J1	
R2	Comp. 47 kΩ ±5% .25 W	6099-3475	75042	BTS, 47 kΩ ±5%	5905-683-2246
R3	Comp. 100 Ω ±5% .25 W	6099-1105	75042	BTS, 100 Ω ±5%	
R4	Comp. 2.2 kΩ ±5% .25 W	6099-2225	75042	BTS, 2.2 kΩ ±5%	5905-723-5251
R5	Comp. 10 kΩ ±5% .25 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R6	Comp. 10 kΩ ±5% .25 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R7	Pot. Comp. 5 kΩ ±30%	6049-0108	98474	597040	
R8	Comp. 1 kΩ ±5% .25 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R9	Comp. 10 Ω ±5% .25 W	6099-0105	75042	BTS, 10 Ω ±5%	5905-809-8596
R10	Comp. 10 Ω ±5% .25 W	6099-0105	75042	BTS, 10 Ω ±5%	5905-809-8596
R11	Comp. 1.5 kΩ ±5% .25 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R12	Comp. 220 Ω ±5% .25 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
CAPACITORS					
C1	Ceramic, .01 μF	4401-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C2	Ceramic, .01 μF	4406-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C3	Ceramic, .01 μF	4406-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C4	Ceramic, .01 μF	4406-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C5	Ceramic, .01 μF	4406-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C6	Ceramic, .01 μF	4406-3100	80131	CC61, .01 μF +80-20%	5910-974-5697
C7	Mica, 270 pF ±1%	4710-0450	14655	22A, 270 pF ±1%	
C8	Mica, 270 pF ±1%	4710-0450	14655	22A, 270 pF ±1%	
INDUCTORS					
L1	Choke molded, 12 μH ±10%	4300-2300	99800	1537-38, 12 μH ±10%	5950-807-6050
L2	Choke molded, 12 μH ±10%	4300-2300	99800	1537-38, 12 μH ±10%	5950-807-6050
L3		1165-2456	24655	1165-2456	
L4		1165-2456	24655	1165-2456	
DIODES					
CR1	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR2	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR3	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR4	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N4258	8210-1136	93916	2N4258	
Q3	Type 2N4258	8210-1136	93916	2N4258	
TRANSFORMER					
T1		1165-2457	24655	1165-2457	
1165-4130 EXTERNAL DRIVE INPUT UNIT (Z)					
JACK					
J1	Multiple Socket	4230-2301	09408	UG-1094A/U	
SWITCH					
S1	Slide, DPDT	7910-0832	82389	11A-1118	
INTEGRATED CIRCUITS					
IC1	Digital	5431-9610	04713	MC1013L	
IC2	Digital	5431-9609	24655	5431-9609	

Figure 6-5. Input circuit etched-board assembly (P/N 1165-4060).

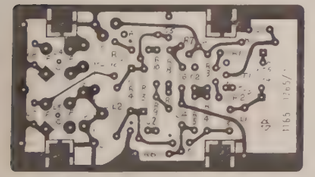


Figure 6-6. Input filter circuit etched-board assembly (P/N 1165-4065).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

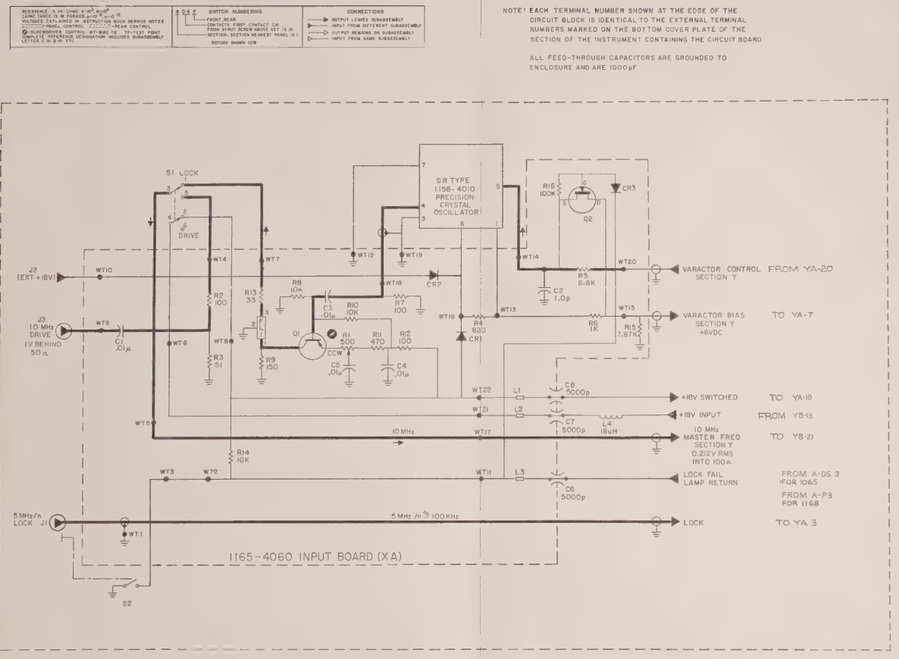

NOTE! EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD
ALL FEED-THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF
S1 LOCK
DRIVE
GR TYPE 1158-4010 PRECISION CRYSTAL OSCILLATOR
J2 (EXT +18V)
J3 10 MHz DRIVE 1V BEHIND 50Ω
5 MHz/n LOCK J1
S2
VARACTOR CONTROL FROM YA-20 SECTION Y
VARACTOR BIAS SECTION Y +6VDC
TO YA-7
+18V SWITCHED
TO YA-18
+18V INPUT
FROM YB-13
10 MHz MASTER FREQ SECTION Y 0.212V RMS INTO 100Ω
TO YB-21
LOCK FAIL LAMP RETURN
FROM A-DS 3 FOR 1065
FROM A-P3 FOR 1168
5 MHz /n 100 KHz
LOCK
TO YA 3
1165-4060 INPUT BOARD (XA)
TRANSISTOR BASING (BOTTOM VIEW)
FILTER BASING (BOTTOM VIEW)
FL1

Figure 6-7. Master oscillator unit wiring diagram.

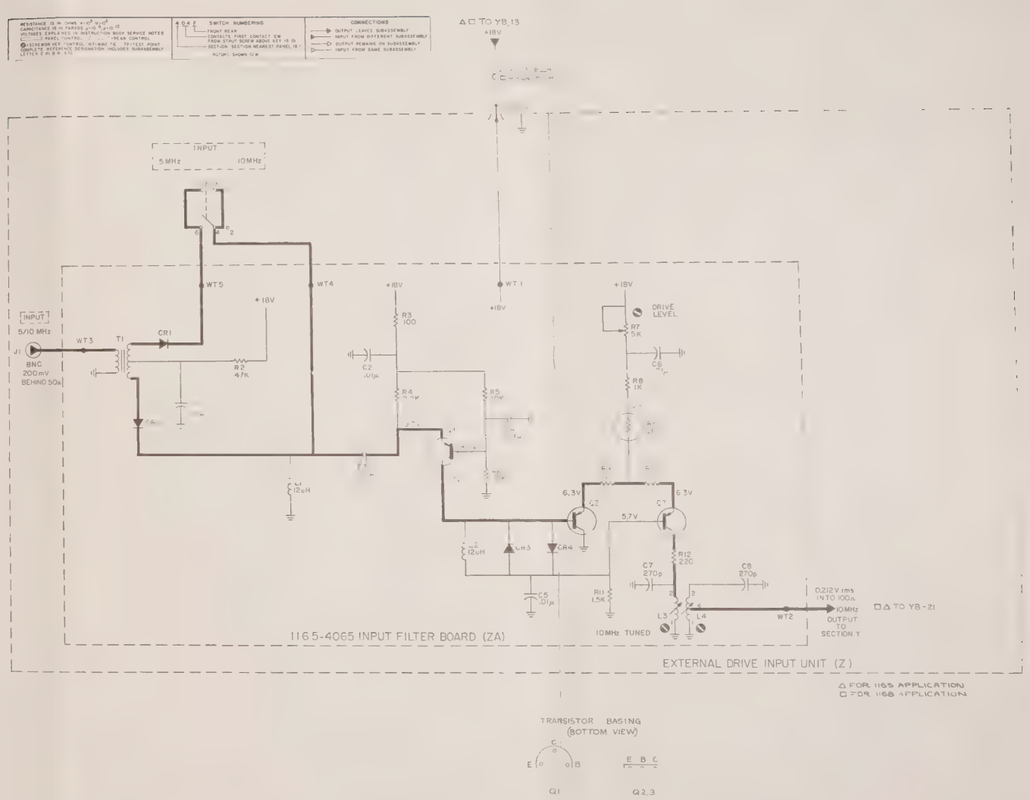


Figure 6-8. External drive input unit wiring diagram.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4016 LOCK CIR. (YA)					
CAPACITORS					
C1	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C2	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C3	Ceramic 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	5910-974-5695
C4	Ceramic 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	5910-974-5695
C5	Ceramic 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF ±10%	
C6	Mica 1500 pF ±5% 500 V	4700-0690	14655	22A, 1500 pF ±5%	
C7	Mica 1500 pF ±5% 500 V	4700-0690	14655	22A, 1500 pF ±5%	
C8	Ceramic 30 pF ±5% 100 V	4411-2003	72982	831, 30 pF ±5%	
C9	Ceramic 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	5910-974-5695
C10	Ceramic 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	5910-974-5695
C11	Ceramic 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	5910-974-5695
C12	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C13	Ceramic 220 pF ±10% 500 V	4404-1228	72982	831, 220 pF ±10%	
C14	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C15	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C16	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C17	Ceramic 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	5910-974-5695
C18	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C19	Ceramic 300 µF +20% 500 V	4404-2100	72982	831, .001 µF ±20%	
C20	Ceramic .001 µF +20% 500 V	4404-2100	72982	831, .001 µF ±20%	
C21	Ceramic .047 µF +20% 500 V	4405-2470	72982	801, .0047 µF ±20%	
C22	Ceramic .0047 µF +20% 500 V	4405-2470	72982	801, .0047 µF ±20%	
C23	Ceramic 0.1 µF +20% 25 V	4400-2050	80183	5C13, .1 µF ±20%	
C24	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C25	Electrolytic 47 µF +20% 6 V	4450-5500	56289	150D476X0006B2	5910-752-4185
C26	Electrolytic 4.7 µF +20% 10 V	4450-4700	56289	150D465X0015B2	5910-813-8160
C27	Ceramic .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
DIODES					
CR1	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR2	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR3	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR4	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR5	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR6	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR7	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR8	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR9	Type 1N455	6082-1010	07910	1N455	5960-877-8255
CR10	Type 1N455	6082-1010	07910	1N455	5960-877-8255
INTEGRATED CIRCUITS					
U1	Linear	5432-7102	04713	MC1710CP	
U2	Linear	5432-7102	04713	MC1710CP	
U3	Linear	5432-8028	29809	CA328A	
RESISTORS					
R1	Comp 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R2	Comp 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R3	Comp 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R4	Comp 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R5	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R6	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	5905-688-3738
R7	Comp. 68 kΩ ±5% 1/8 W	6098-1685	01121	BB, 68 kΩ ±5%	
R8	Comp. 390 kΩ ±5% 1/8 W	6098-4395	01121	BB, 390 kΩ ±5%	
R9	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R10	Comp. 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R11	Comp 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R12	Comp 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ ±5%	5905-688-3738
R13	Comp 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R14	Comp 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R15	Comp 68 kΩ ±5% 1/4 W	6099-1685	75042	BTS, 68 kΩ ±5%	5905-681-8853
R16	Comp. 390 kΩ ±5% 1/8 W	6098-4395	01121	BB, 390 kΩ ±5%	
R17	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R18	Comp. 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R19	Comp. 8.2 kΩ ±5% 1/4 W	6099-2825	75042	BTS, 8.2 kΩ ±5%	
R20	Comp 180 Ω ±5% 1/4 W	6099-1185	75042	BTS, 180 Ω ±5%	5905-279-5476
R21	Comp. 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R22	Pot. Comp. 1 kΩ ±10%	6049-0295	01121	ZH1021	
R23	Comp. 2.2 kΩ ±5% 1/8 W	6098-2225	01121	BB, 2.2 kΩ ±5%	
R24	Comp. 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R25	Comp. 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R26	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R27	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R28	Comp. 2.2 kΩ ±5% 1/8 W	6098-2225	01121	BB, 2.2 kΩ ±5%	
R29	Comp. 2.2 kΩ ±5% 1/8 W	6098-2225	01121	BB, 2.2 kΩ ±5%	
R30	Comp. 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1 kΩ ±5%	5905-681-6462
R31	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R32	Comp. 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ ±5%	5905-687-0002
R33	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R34	Comp. 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R35	Comp. 680 Ω ±5% 1/8 W	6098-1685	01121	BB, 680 Ω ±5%	
R36	Comp. 2.2 kΩ ±5% 1/8 W	6098-2225	01121	BB, 2.2 kΩ ±5%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSISTORS					
Q1	Type 2N4275	8210-1126	23342	2N4275	
Q2	Type 2N3903	8210-1132	93916	2N3903	
Q3	Type 2N3903	8210-1132	93916	2N3903	
Q4	Type 2N4125	8210-1125	93916	2N4125	
Q5	Type MPS-A65	8210-1220	04713	MPS-A65	
Q6	Type 2N3391A	8210-1092	24454	2N3391A	
Q7	Type 2N4125	8210-1125	93916	2N4125	
INDUCTORS					
L1		1165-2440	24655	1165-2440	
L2		1165-2440	24655	1165-2440	
L3	Choke, 680 µH ±10%	4300-6386	99800	1537-742, 680 µH ±10%	
(1165-4038)--					
Q5	Type 2N5179	8210-1195	79089	2N5179	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4038 BUFFER CIR. (YB)					
CAPACITORS					
C1	Trimmer 7-25 pF 350 V	4910-2032	[illegible]	538-006, 7-25 pF	5910-998-1621
C2	Ceramic 62 pF ±5% 100 V	4411-2002	[illegible]	831, 62 pF ±5%	
C3	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C4	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C5	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C6	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C7	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C8	Trimmer 7-25 pF 350 V	4910-2032	[illegible]	538-006, 7-25 pF	5910-998-1621
C9	Ceramic 62 pF ±5% 100 V	4411-2002	[illegible]	831, 62 pF ±5%	
C10	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C13	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C14	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C15	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C16	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C17	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C18	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C19	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C20	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C21	Ceramic .01 µF +80-20% 100 V	4401-3100	[illegible]	CC61, .01 µF +80-20%	5910-974-5697
C22	Trimmer 7-25 pF 350 V	4910-2032	[illegible]	538-006 7-25 pF	5910-998-1621
C23	Ceramic 62 pF ±5% 100 V	4411-2002	[illegible]	831, 62 pF ±5%	
C24	Trimmer 7-25 pF 350 V	4910-2032	[illegible]	538-006, 7-25 pF	5910-998-1621
C25	Ceramic 62 pF ±5% 100 V	4411-2002	[illegible]	831, 62 pF ±5%	
RESISTORS					
R1	Comp. 2.2 kΩ ±5% 1/4 W	6099-2225	[illegible]	BTS, 2.2 kΩ ±5%	5905-723-5251
R2	Comp. 2.2 kΩ ±5% 1/4 W	6099-2225	[illegible]	BTS, 2.2 kΩ ±5%	5905-723-5251
R3	Comp. 100 Ω ±5% 1/4 W	6099-1105	[illegible]	BTS, 100 Ω ±5%	5905-723-5251
R4	Comp. 2.2 kΩ ±5% 1/4 W	6099-2225	[illegible]	BTS, 2.2 kΩ ±5%	5905-723-5251
R5	Comp. 240 Ω ±5% 1/4 W	6099-1245	[illegible]	BTS, 240 Ω ±5%	5905-
R6	Comp. 150 Ω ±5% 1/4 W	6099-1155	[illegible]	BTS, 150 Ω ±5%	5905-683-2243
R7	Comp. 2.2 kΩ ±5% 1/4 W	6099-2225	[illegible]	BTS, 2.2 kΩ ±5%	5905-723-5251
R8	Comp. 470 Ω ±5% 1/4 W	6099-1475	[illegible]	BTS, 470 Ω ±5%	5905-683-2242
R9	Comp. 100 Ω ±5% 1/4 W	6099-1105	[illegible]	BTS, 100 Ω ±5%	
R10	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	[illegible]	BTS, 1.5 kΩ ±5%	
R12	Comp. 220 Ω ±5% 1/4 W	6099-1225	[illegible]	BTS, 220 Ω ±5%	[illegible]
R13	Comp. 220 Ω ±5% 1/4 W	6099-1225	[illegible]	BTS, 220 Ω ±5%	5905-683-2240
R14	Comp. 10 kΩ ±5% 1/4 W	6099-3105	[illegible]	BTS, 10 kΩ ±5%	5905-683-2238
R15	Comp. 10 kΩ ±5% 1/4 W	6099-3105	[illegible]	BTS, 10 kΩ ±5%	5905-683-2238
R16	Comp. 1 kΩ ±5% 1/4 W	6099-2105	[illegible]	BTS, 1 kΩ ±5%	5905-681-6462
R17	Comp., 47 Ω ±5% 1/4 W	6099-0475	[illegible]	BTS, 33 Ω 5%	
R18	Comp., 68 Ω ±5% 1/4 W	6099-0685	[illegible]	BTS, 39 Ω ±5%	
R19	Comp. 680 Ω ±5% 1/4 W	6099-1685	[illegible]	BTS, 680 Ω ±5%	
R20	Comp. 510 Ω ±5% 1/4 W	6099-1515	[illegible]	BTS, 510 Ω ±5%	
R21	Comp. 680 Ω ±5% 1/4 W	6099-1685	[illegible]	BTS, 680 Ω ±5%	
R22	Comp 680 Ω ±5% 1/4 W	6099-1685	[illegible]	BTS, 680 Ω ±5%	
R23	Comp. 620 Ω ±5% 1/4 W	6099-1625	[illegible]	BTS, 620 Ω ±5%	
R24	Comp. 620 Ω ±5% 1/4 W	6099-1625	[illegible]	BTS, 620 Ω ±5%	
R25	Comp. 47 Ω ±5% 1/4 W	6099-0475	[illegible]	BTS, 47 Ω ±5%	
R27	Comp. 100 Ω ±5% 1/4 W	6099-1105	[illegible]	BTS, 100 Ω ±5%	
R28	Comp. 100 Ω ±5% 1/4 W	6099-1105	[illegible]	BTS, 100 Ω ±5%	
TRANSISTORS					
Q1	Type 2N5179	8210-1195	[illegible]	2N5179	
Q2	Type 2N5179	8211-1195	[illegible]	2N5179	
Q3	Type 2N3903	8210-1132	[illegible]	2N3903	
Q4	Type 2N5179	8210-1195	[illegible]	2N5179	
Q5	Type 2N5179	8210-1195		2N5179	
TRANSFORMERS					
T1	3.3 µH ±5%	1165-2038	[illegible]	1165-2038	
T2	3.3 µH ±5%	1165-2038	[illegible]	1165-2038	
T3	3.3 µH ±5%	1165-2039	[illegible]	1165-2039	
T4	3.3 µH ±5%	1165-2039	[illegible]	1165-2039	

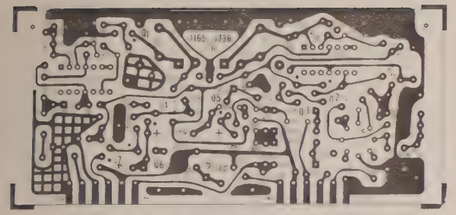


Figure 6-9. Lock circuit etched-board assembly (P/N 1165-4036).

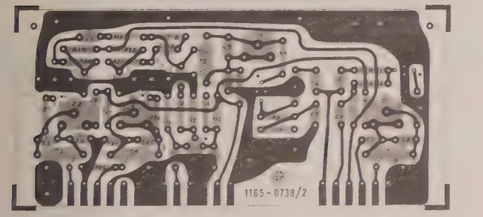


Figure 6-10. Buffer circuit etched-board assembly (P/N 1165-4038).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

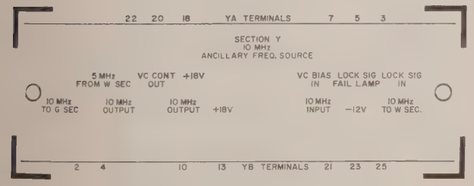
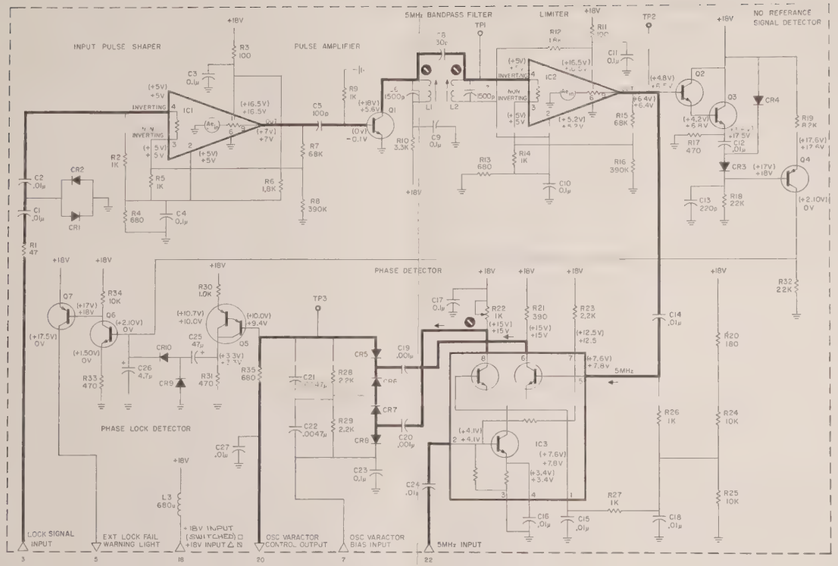


Figure 6-11. Bottom cover, exterior view, of section Y.



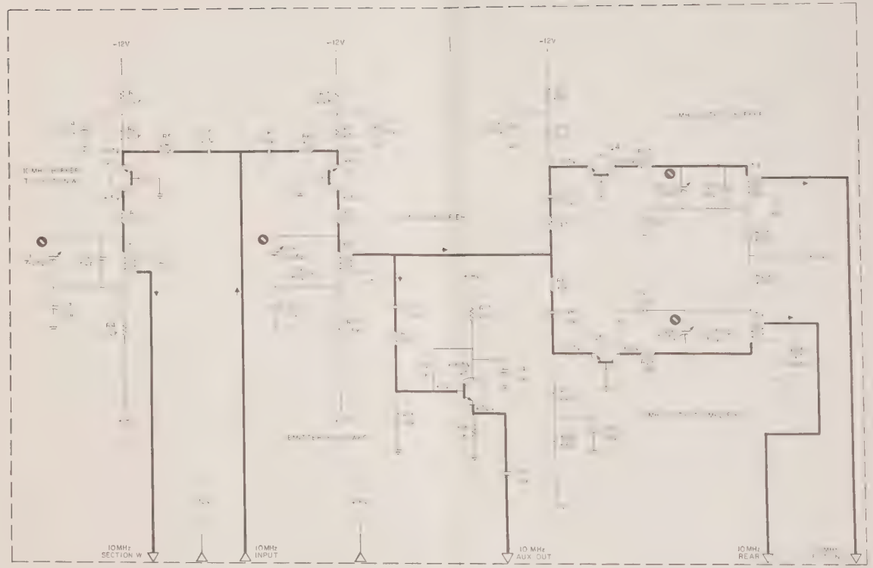
RESISTANCE IS IN OHMS
SWITCH NUMBERING
FRONT PEAK
CONTACTS FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY 18 ON SECTION SECTION HEAVIEST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

TRANSISTOR BASING (BOTTOM VIEW)

NOTE: D.C. VALUES IN ( ) TAKEN WITHOUT 5MHz REF AT PIN 3

GROUND TERMINALS
2,4,6,10,21,23

NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD.
ALL FEED THROUGH CAPACITORS ARE MOUNTED TO ENCLOSURE AND ARE 1000 pF



GROUND TERMINALS
3,5,7,9,11,12,14,22, 24,26

TRANSISTOR BASING (BOTTOM VIEW)

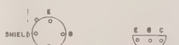


Figure 6-12. Section Y.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4032 DIV. CIR. (WA) (AFS-42)					
CAPACITORS					
C1	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C2	Ceramic, .10 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C3	Ceramic, 1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF 20%	5910-083-6445
C4	Ceramic, 9.1 pF ±5% 500 V	4411-9915	72982	831, 9.1 pF 5%	
C5	Ceramic, 75 pF ±5% 500 V	4404-0755	72982	831, 75 pF 5%	
C6	Ceramic, 39 pF ±5% 500 V	4404-0395	72982	831,39 pF 5%	
C7	Ceramic, 9.1 pF ±5% 500 V	4411-9915	72982	831, 9.1 pF 5%	
C8	Ceramic, 75 pF ±5% 500 V	4404-0755	72982	831, 75 pF 5%	
C9	Ceramic, 39 pF ±5% 500 V	4404-0395	72982	831,39 pF 5%	
C10	Ceramic, 1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF 20%	5910-083-6445
C11	Ceramic, 2.2 µF ±20% 25 V	4400-2080	80183	5C13, 2.2 µF 20%	
C12	Ceramic, 150 pF ±10% 500 V	4404-1158	72982	831, 150 pF 10%	
C13	Mica, 1200 pF ±5% 500 V	4700-0685	14655	22A, 1200 pF	
C14	Ceramic, 2.2 µF ±20% 25 V	4400-2080	80183	5C13, 2.2 µF 20%	
C15	Ceramic, 150 pF ±10% 500 V	4404-1158	72982	831, 150 pF 10%	
C16	Mica, 1200 pF ±5% 500 V	4700-0685	14655	22A, 1200 pF	
C17	Electrolytic, 47 µF +20% 20 V	4450-5712	37942	TT, 47 µF 20%	
C18	Ceramic, 2.2 µF ±20% 25 V	4400-2080	80183	5C13, 2.2 µF 20%	
C19	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
INTEGRATED CIRCUITS					
IC1	Digital	5431-9613	82219	SF123	
IC2	Digital	5431-8190	01295	SN7490N	
IC3	Digital	5431-8190	01295	SN7490N	
RESISTORS					
R1	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R2	Comp., 120 Ω 1/4 W	6099-1125	75042	BTS, 120 Ω 5%	
R3	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R4	Comp., 120 Ω ±5% 1/4 W	6099-1125	75042	BTS, 120 Ω 5%	5905-686-3369
R5	Comp., 18 Ω ±5% 1/4 W	6099-0185	75042	BTS, 18 Ω 5%	
R7	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R8	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R9	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R10	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R11	Comp., 18 Ω ±5% 1/4 W	6099-0185	75042	BTS, 18 Ω 5%	
R13	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R14	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R15	Comp., 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ 5%	5905-687-0002
R17	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R18	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R19	Comp., 22 kΩ ±5% 1/4 W	6099-3225	75042	BTS, 22 kΩ 5%	5905-687-0002
R20	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R21	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	5905-686-3369
R22	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R23	Comp., 18 Ω ±5% 1/4 W	6099-0185	75042	BTS, 18 Ω 5%	
TRANSISTORS					
Q1	Type 2N4258	8210-1136	93916	2N4258	
Q2	Type 2N3905	8210-1114	04713	2N3905	
Q3	Type 2N3905	8210-1114	04713	2N3905	
Q4	Type 2N3903	8210-1132	93916	2N3903	
TRANSFORMERS					
T1	Part of 1160-2430	1160-0470	24655	1160-0470	
T2		1160-0470	24655	1160-0470	
INDUCTORS					
L1	Choke, molded 12 µH ±5%	4300-2305	99800	1537, 12 µH 5%	
L2	Choke, molded 22 µH ±10%	4300-2600	99800	1537, 22 µH 10%	5950-668-5867
L3	Choke, molded 12 µH ±5%	4300-2305	99800	1537, 12 µH 5%	
L4	Choke, molded 22 µH ±10%	4300-2600	99800	1537, 22 µH 10%	5950-668-5867
L7	22 µH ±10%	4300-2600	99800	1537, 22 µH 10%	5950-951-9266
L8	22 µH ±10%	4300-2600	99800	1537, 22 µH 10%	5950-951-9266

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4034 42 MHz BOARD (WB) (AFS-42)					
C1	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C2	Mica, 300 pF ±1% 500 V	4710-0461	14655	22A, 300 pF ±1%	
C3	Ceramic, .001 µF ±5% 500 V	4405-2105	72982	801, .001 µF ±5%	
C4	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C5	Ceramic, .02 µF +80-20% 100 V	4402-3200	01121	35-203W	5910-952-9659
C6	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C7	Mica, 300 pF ±1% 500 V	4710-0461	14655	22A, 300 pF ±1%	
C8	Ceramic, 3.9 pF ±5% 500 V	4410-9395	72982	831, 3.9 pF ±5%	
C9	Mica, 300 pF ±1% 500 V	4710-0461	14655	22A, 300 pF ±1%	
C10	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C11	Ceramic, 120 pF ±5% 100 V	4415-1000	72982	0875037S2H00121J	
C12	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C13	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C14	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C15	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C16	Ceramic, 82 pF ±5% 100 V	4414-1200	72982	0855037R2G00820J	
C17	Ceramic, 15 pF ±5% 500 V	4411-0155	72982	801, 15 pF ±5%	
C18	Ceramic, .0022 µF +80-20% 500 V	4404-2229	72982	831, .0022 µF +80-20%	
C19	Ceramic, 100 pF ±5% 100 V	4414-1201	72982	0855037R2G00101J	
C20	Ceramic, .0022 µF +80-20% 500 V	4404-2229	72982	831, .0022 µF +80-20%	
C21	Ceramic, .0022 µF +80-20% 500 V	4404-2229	72982	831, .0022 µF +80-20%	
C22	Ceramic, .0022 µF +80-20% 500 V	4404-2229	72982	831, .0022 µF +80-20%	
RESISTORS					
R1	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R2	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-279-5481
R3	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-279-5481
R4	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R5	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R6	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R7	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R8	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R9	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R10	Comp. 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R11	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R12	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R13	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R14	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R15	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R16	Pot. Comp. 5 kΩ ±10%	6049-0297	01121	ZH5021	
R17	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R18	Comp. 33Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R19	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R20	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R21	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R22	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R23	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 100 Ω ±5%	
R24	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1.5 kΩ ±5%	
R25	Comp. 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 1 kΩ ±5%	5905-681-6462
R26	Comp. 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R27	Comp. 620 Ω ±5% 1/4 W	6099-1625	75042	BTS, 620 Ω ±5%	5905-801-6998
R28	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R29	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N3905	8210-1114	04713	2N3905	
Q3	Type 2N3903	8210-1132	93916	2N3903	
Q4	Type 2N3905	8210-1114	04713	2N3905	
Q5	Type 2N3905	8210-1114	04713	2N3905	
Q6	Type 2N3903	8210-1132	93916	2N3903	
Q7	Type 2N3903	8210-1132	93916	2N3903	
DIODES					
CR1	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR2	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
TRANSFORMERS					
T1		1165-2460	24655	1165-2460	
T2		1165-2465	24655	1165-2465	
INDUCTORS					
L1		1165-2450	24655	1165-2450	
L2		1165-2445	24655	1165-2445	
L3		1165-2445	24655	1165-2445	
L4	Choke, Molded 1 µH ±10%	4300-0700	99800	1537, 1 µH ±10%	5950-683-7984
L5		1165-2455	24655	1165-2455	

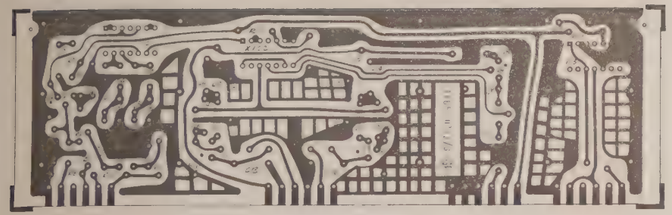


Figure 6-13. Divider circuit etched-board assembly (P/N 1165-4032).

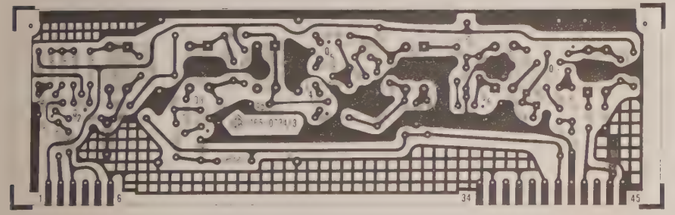


Figure 6-14. 42-MHz circuit etched-board assembly (P/N 1165-4034).

NOTE: The board is shown foil-side up. The number appearing on the foil side *is not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

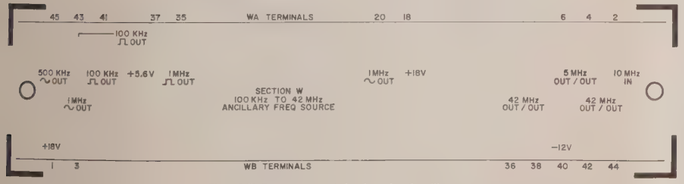
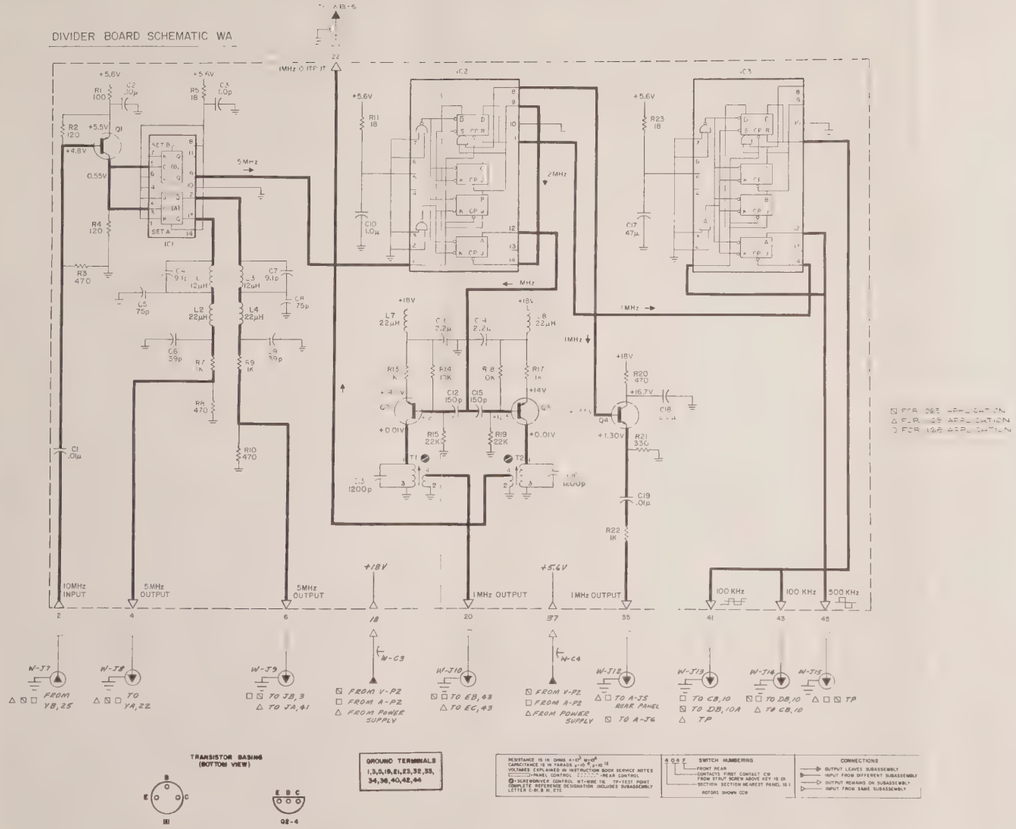


Figure 6-15. Bottom cover, exterior view, of section W.



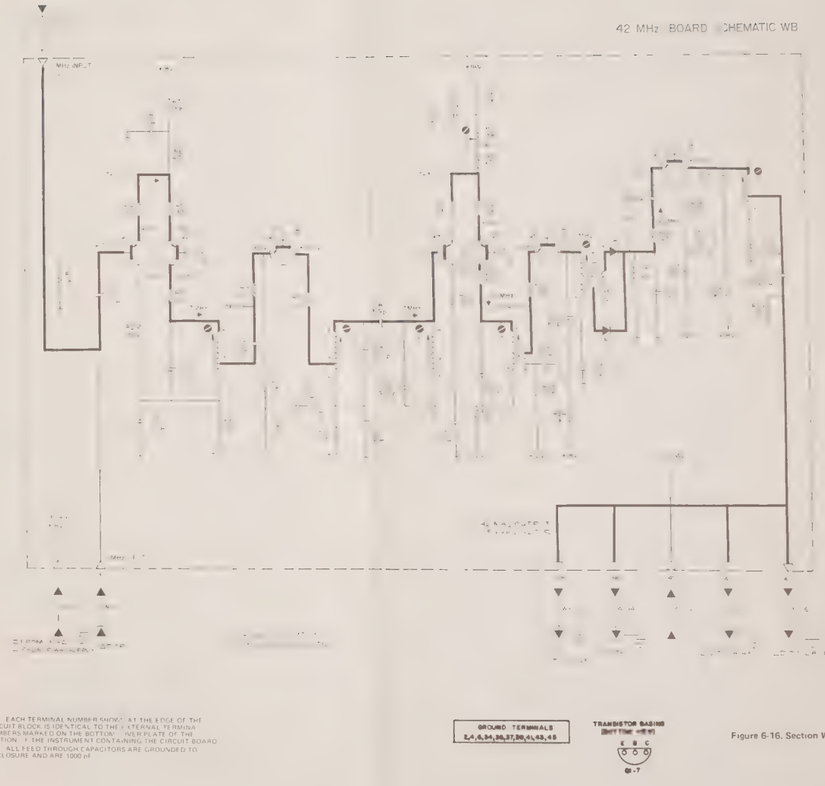


Figure 6-16. Section W.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4001 OSC. CIR (CA) (DO - 3-5)					
CAPACITORS					
C1	Electrolytic	4450-5723	91021	2000031100107	
C2	Electrolytic, 150 µF +20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C3	Ceramic, 15 pF ±20% 200 V	4410-0245	72982	831, 24 pF 5%	
C4	Plastic, .24 pF ±5% 100 V	4860-7974	84411	663UW, .22 µF 5%	
C5	Plastic, .22 µF ±5% 100 V	4860-7955	84411	663UW, .01 µF 5%	
C6	Plastic, .01 µF ±5% 100 V	4850-7752	84411	663UW, .01 µF 1%	
C7	Plastic, .01 µF ±1% 100 V	4860-7246	84411	663UW, .0068 µF 1%	
C8	Plastic, .0068 µF ±1% 200 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C9	Electrolytic, 15 µF ±20% 20 V	4405-2105	72982	801, .001 µF 5%	
C10	Ceramic, .001 µF ±5% 500 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C11	Ceramic, .01 µF +80-20% 100 V	4700-0516	14655	22A, 330 pF 5%	
C12	Mica, 330 pF ±5% 500 V	4910-2031	72982	831, 5.5-18 pF	
C13	Trimmer, 5.5-18 pF 350 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C14	Electrolytic, 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C15	Electrolytic, 15 µF ±20% 20 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C16	Ceramic, .01 µF +80-20% 100 V	4860-7860	84411	663 UW, .022 µF 1%	5910-055-6119
C17	Plastic, .022 µF ±10% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C18	Ceramic, .01 µF +80-20% 100 V	4700-0443	14655	22A515, 100 pF 1	
C19	Mica, 100 pF ±2% 500 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C20	Ceramic, .01 µF +80-20% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C21	Ceramic, .01 µF +80-20% 100 V				
RESISTORS					
R1	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R2	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R3	Comp., 12 kΩ ±5% 1/4 W	6099-3123	75042	BTS, 12 kΩ 5%	
R4	Comp., 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ 5%	
R5	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-9969
R6	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R7	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R8	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	5905-686-3369
R9	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R10	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R11	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R12	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R13	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R14	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R15	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-9969
R16	Comp., 10 Ω ±5% 1/4 W	6099-0105	75042	BTS, 10 Ω 5%	5905-809-8596
R17	Pot. Comp., 1 kΩ ±10% 1/2 W	0019-0295	01121	ZH1021	
R18	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R19	Comp., 3 kΩ ±5% 1/4 W	6099-2305	75042	3TS, 3 kΩ 5%	5905-682-4097
R20	Comp., 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ 5%	
R21	Film, 118 kΩ ±1% 1/8 W	6250-3118	75042	CEA, 118 kΩ 1%	
R22	Film, 118 kΩ ±1% 1/8 W	6250-3118	75042	CEA, 118 kΩ 1%	
R23	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R24	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ 5%	5905-681-8818
R25	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ 5%	5905-681-8818
R26	Comp., 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω 5%	
R27	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R28	Comp., 11 kΩ ±5% 1/4 W	6099-3115	75042	BTS, 11 kΩ 5%	
R29	Comp., 11 kΩ ±5% 1/4 W	6099-3115	75042	BTS, 11 kΩ 5%	
R30	Comp., 12 kΩ ±5% 1/4 W	6099-3125	75042	BTS, 12 kΩ 5%	
R31	Comp., 4.7 Ω ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ 5%	5905-686-9998
R32	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R33	Comp., 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ 5%	5905-686-3129
R34	Comp., 39 kΩ ±5% 1/4 W	6099-3395	75042	BTS, 39 kΩ 5%	5905-686-3358
R35	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ 5%	5905-681-8818
R36	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R37	Comp., 3.9 MΩ ±5% 1/4 W	6099-5395	75042	BTS, 3.9 MΩ 5%	
R38	Comp., 2 MΩ ±5% 1/4 W	6099-5205	75042	BTS, 2 MΩ 5%	
R39	Comp., 560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω 5%	
R40	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R41	Comp., 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω 5%	5905-682-4107
R42	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R43	Comp., 110 kΩ ±5% 1/4 W	6099-4115	75042	BTS, 110 kΩ 5%	
R44	Comp., 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ 5%	5905-686-3368
R45	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R46	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-9969

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSISTORS					
Q1	Type 2N4123	8210-1123	93916	2N4123	
Q2	Type 2N3905	8210-1114	04713	2N3905	
Q3	Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q4	Type 2N3903	8210-1132	93916	2N3903	
Q5	Type 2N3905	8210-1114	04713	2N3905	
Q6	Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q7	Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q8	Type 2N2218	8210-1028	81349	2N2218	5960-059-4464
Q9	Type DN259	8210-1170	17856	DN259	
Q10	Type 2N3903	8210-1132	93916	2N3903	
Q11	Type 2N3905	8210-1114	04713	2N3905	
Q12	Type 2N3905	8210-1114	04713	2N3905	
Q13	Type 40673	8210-1193	56289	3N159	
Q14	Type 40673	8210-1193	56289	3N159	
Q15	Type 2N3903	8210-1132	93916	2N3903	
Q16	Type 2N4123	8210-1123	93916	2N4123	
DIODES					
CR1	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR2	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR3	Type 1N4442	6082-1009	24446	1N4442	5961-929-9967
CR4	Type 1N4442	6082-1009	24446	1N4442	5961-929-9967
CR5	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR6	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR7	Type 1N4442	6082-1009	24446	1N4442	5961-929-9967
CR8	Type 1N4442	6082-1009	24446	1N4442	5961-929-9967
CR9	Type V900B	6084-1029	77630	V900B	
TRANSFORMERS					
T1	Coil	5000-2121	24655	5000-2121	
T2		1165-2300	24655	1165-2300	
INDUCTORS					
L1	Choke, molded 17-19 µH	4300-3700	79089	81218	
L2	Choke, molded 18 µH ±10%	4300-2500	99800	1537-42, 18 µH 10%	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4002 PROGRAM BOARD (CB)					
CAPACITORS					
C1	Electrolytic, 330 µF ±20% 6 V	4450-5707	37942	TT, 330 µF 20%	
C2	Mica, 464 pF ±1% 500 V	4710-0535	14655	22A, 464 pF 1%	
C3	Ceramic, .001 µF ±5% 500 V	4405-2105	72982	801, .001 µF 5%	
INTEGRATED CIRCUITS					
IC1	Digital	5431-8190	96214	SN7490N	
IC2	Digital	5431-8190	96214	SN7490N	
IC3	Digital	5431-8100	96214	SN7400N	
IC4	Digital	5431-8100	96214	SN7400N	
IC5	Digital	5431-8176	96214	SN7476N	
IC6	Digital	5431-9604	18324	N8280A	
IC7	Digital	5431-9604	18324	N8280A	
IC8	Digital	5431-9604	18324	N8280A	
IC9	Digital	5431-9604	18324	N8280A	
IC10	Digital	5431-9362	07263	DTµL-936	
IC11	Digital	5431-9362	07263	DTµL-936	
IC12	Digital	5431-9462	07263	DTµL-946	
IC13	Digital	5431-9462	07263	DTµL-946	
IC14	Digital	5431-8210	96214	SN74H10N	
RESISTORS					
R1	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R2	Comp., 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R3	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R4	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R5	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R9	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R10	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R11	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R12	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R13	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R14	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 10 kΩ 5%	
R15	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R16	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ 5%	
R17	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 10 kΩ 5%	
R18	Comp., 470 Ω ±5% 1/8 W	6098-1475	01121	BB, 470 Ω 5%	
R19	Comp., 10 kΩ ±5% 1/8 W	6098-3105	01121	BB, 10 kΩ 5%	
R20	Comp., 10 kΩ ±5% 1/8 W	6098-3105	01121	BB, 10 kΩ 5%	
R21	Comp., 10 kΩ ±5% 1/8 W	6098-3105	01121	BB, 10 kΩ 5%	
DIODES					
CR1	Type 1N995	6082-1002	80368	1N995	
CR2	Type 1N995	6082-1002	80368	1N995	
CR3	Type 1N995	6082-1002	80368	1N995	
CR4	Type 1N995	6082-1002	80368	1N995	
CR5	Type 1N995	6082-1002	80368	1N995	
CR9	Type 1N995	6082-1002	80368	1N995	
CR10	Type 1N995	6082-1002	80368	1N995	
CR11	Type 1N995	6082-1002	80368	1N995	
CR12	Type 1N995	6082-1002	80368	1N995	
CR13	Type 1N995	6082-1002	80368	1N995	
CR14	Type 1N995	6082-1002	80368	1N995	
CR15	Type 1N995	6082-1002	80368	1N995	
CR16	Type 1N995	6082-1002	80368	1N995	
CR17	Type 1N995	6082-1002	80368	1N995	
CR18	Type 1N995	6082-1002	80368	1N995	
CR19	Type 1N995	6082-1002	80368	1N995	
CR21	Type 1N995	6082-1002	80368	1N995	
CR22	Type 1N995	6082-1002	80368	1N995	
CR23	Type 1N995	6082-1002	80368	1N995	
SOCKETS					
SO1		7540-1814	70763	141-001-111N	
SO2		7540-1814	70763	141-001-111N	
SO3		7540-1814	70763	141-001-111N	

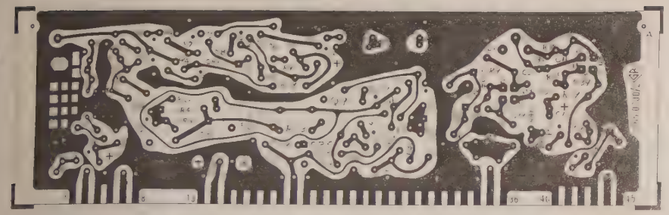


Figure 6-17. Oscillator circuit etched-board assembly (P/N 1165-4000).

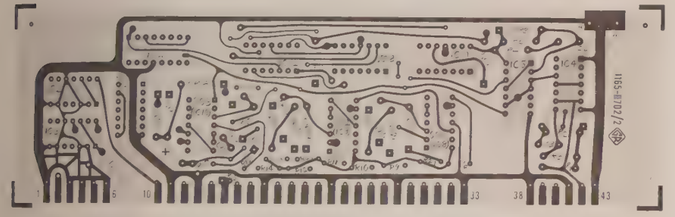


Figure 6-18. Program circuit etched-board assembly (P/N 1165-4002).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

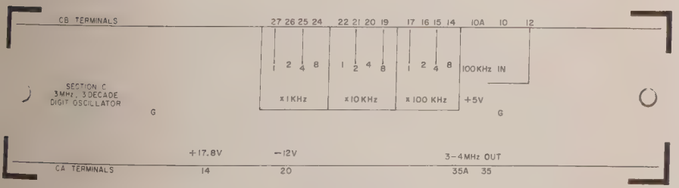
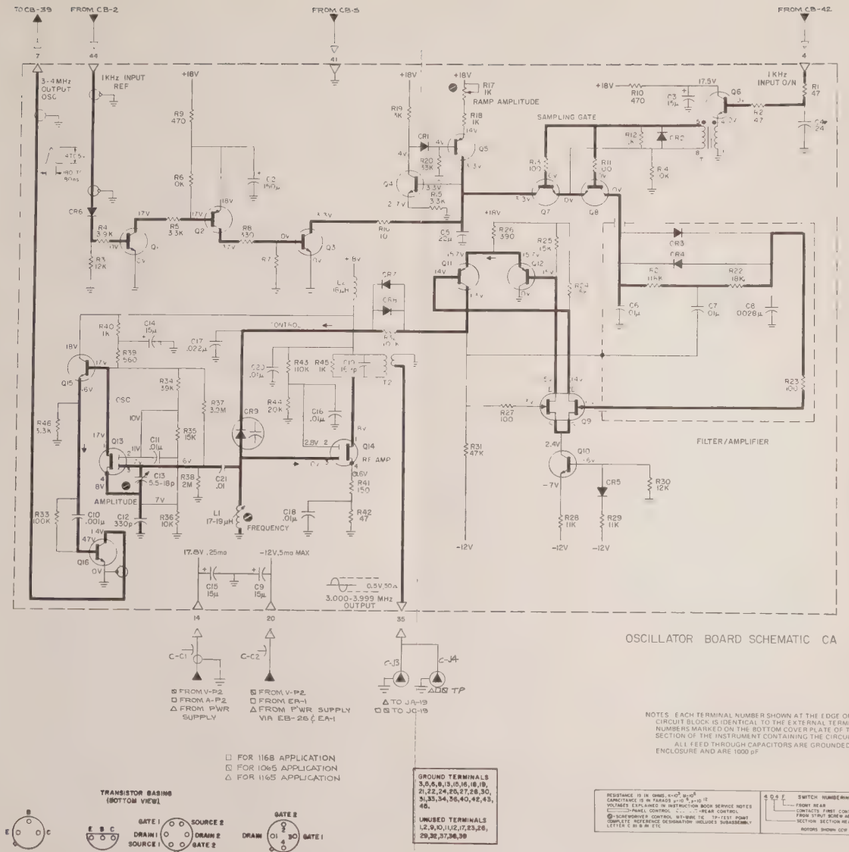


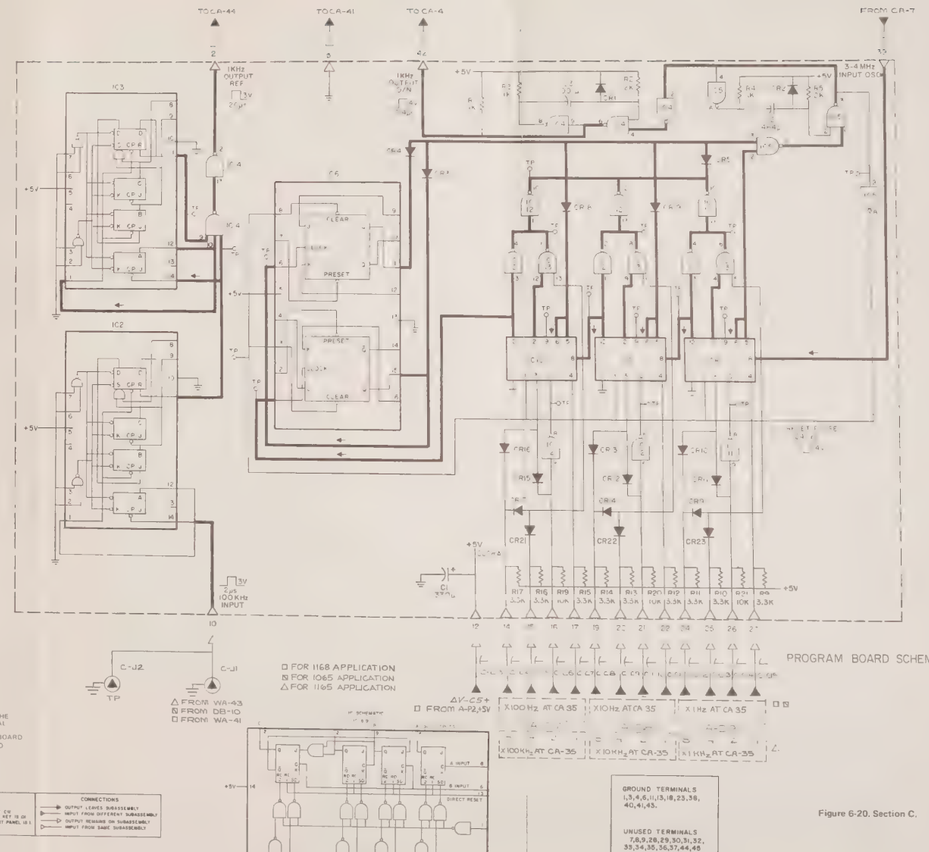
Figure 6-19. Bottom cover, exterior view, of section C.



OSCILLATOR BOARD SCHEMATIC CA

NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD. ALL FEED THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF.

SWITCH NUMBERING
FRONT REAR
CONTACTS FIRST CONTACT CW FROM STUD SCREW ABOVE KEY 10 O'CLOCK SECTION NEAREST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY



PROGRAM BOARD SCHEMATIC CB

Figure 6-20. Section C.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4014 MIX/DIV BOARD (JA) (IMD - 5.1)					
CAPACITORS					
C1	Mica, 169 pF ±2% 500 V	4700-0443	14655	22A, 169 pF 2%	
C2	Ceramic, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C3	Ceramic, 91 pF NO30 ±5% 100 V	4411-2000	72982	831, 91 pF NO30	
C4	Ceramic, .001 µF ±10% 500 V	4405-2108	72982	801, .001 µF 10%	5910-914-0087
C5	Ceramic, .0047 µF ±20% 500 V	4405-2470	72982	801, .0047 µF 20%	
C6	Ceramic, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C7	Ceramic, 68 pF N150 ±5% 100 V	4413-1000	72982	0855037P2G00680J	
C8	Ceramic, .22 pF ±5% 500 V	4400-0022	78488	GA, .22 pF 5%	
C9	Ceramic, 68 pF N150 ±5% 100 V	4413-1000	72982	0855037P2G00680J	
C10	Ceramic, 2.2 pF ±10% 500 V	4411-9225	72982	831, 2.2 µF 10%	
C11	Ceramic, 68 pF N150 ±5% 100 V	4413-1000	72982	0855037P2G00680J	
C12	Ceramic, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C13	Ceramic, 330 pF ±5% 500 V	4404-1335	72982	831, 330 pF 5%	
C14	Ceramic, 330 pF ±5% 500 V	4404-1335	72982	831, 330 pF 5%	
C15	Ceramic, 27 pF NO30 ±5% 100 V	4411-2007	72982	831, 27 pF NO30	
C16	Trimmer, 5.5 - 18 pF NPO 350 V	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
C17	Trimmer, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C18	Trimmer, 2.7 pF ±10% 500 V	4400-0279	78488	GA, 2.7 pF 10%	
C19	Trimmer, 62 pF NO30 ±5% 100 V	4411-2002	72982	831, 62 pF NO30	
C20	Trimmer, 6.8 pF NO30 ±5% 500 V	4411-9685	72982	831, 6.8 pF NO30	
C21	Electrolytic, 3.3 µF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
C22	Electrolytic, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C23	Electrolytic, 3.3 µF 15 V	4450-4600	56289	150D335X0015A	5910-837-9325
C24	Mica, 1200 pF ±5% 500 V	4700-0685	14655	22A, 1200 pF 5%	
C25	Mica, 150 pF ±1% 500 V	4710-0150	14655	22A, 150 pF 1%	
C26	Trimmer, 5.5-18 pF NPO 350 V	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
C27	Ceramic, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C28	Ceramic, .01 µF ±2% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
INTEGRATED CIRCUITS					
IC1	Digital	5431-9610	04713	MC1670S	
IC2	Digital	5431-9609	42498	SD7262	
RESISTORS					
R1	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R2	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R3	Comp., 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ 5%	
R4	Comp., 620 Ω ±5% 1/4 W	6099-1625	75042	BTS, 620 Ω 5%	5905-801-6998
R5	Comp., 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω 5%	5905-683-2243
R6	Comp., 18 kΩ ±5% 1/4 W	6099-3185	75042	BTS, 18 kΩ 5%	5905-687-0000
R7	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-9969
R8	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R9	Comp., 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ 5%	5905-688-3738
R10	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ 5%	5905-681-8818
R11	Comp., 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω 5%	5905-683-2243
R12	Pot. Comp., 200 Ω ±10%	6049-0293	01121	ZH2011	
R13	Comp., 51 Ω ±5% 1/4 W	6099-0515	75042	BTS, 51 Ω 5%	
R14	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R15	Comp., 6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ 5%	5905-686-9997
R16	Comp., 6.8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6.8 kΩ 5%	5905-686-9997
R17	Comp., 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ 5%	
R18	Comp., 1.0 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R19	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R20	Comp., 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω 5%	
R21	Comp., 2.7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2.7 kΩ 5%	
R22	Comp., 18 Ω ±5% 1/4 W	6099-0185	75042	BTS, 18 Ω 5%	
R23	Comp., 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ 5%	5905-688-3738
R24	Comp., 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω 5%	
R25	Comp., 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R27	Comp., 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15 Ω 5%	
R28	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R29	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N3563	8210-1066	07236	2N3563	
Q3	Type 2N3563	8210-1066	07236	2N3563	
Q4	Type 2N3903	8210-1132	93916	2N3903	
Q5	Type 2N3903	8210-1132	93916	2N3903	
Q6	Type 2N4275	8210-1126	23342	2N4275	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSFORMERS					
T1		1160-2610	24655	1160-2610	
T2		1160-2613	24655	1160-2613	
T3		1160-2611	24655	1160-2611	
INDUCTORS					
L1	Choke, molded 12 µH	4300-7525	99800	1537, 12 µH	
L2	Choke, molded	1165-2405	24655	1165-2405	
L3	Choke, molded	1165-2410	24655	1165-2410	
L4	Choke, molded	1165-2415	24655	1165-2415	
L5	Choke, molded	1165-2411	24655	1165-2411	
L6	Choke, molded	1165-2470	24655	1165-2470	
L7	Choke, molded	1165-2415	24655	1165-2415	

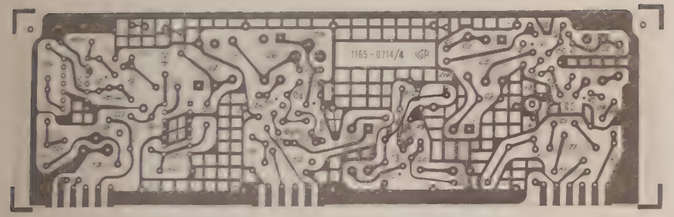


Figure 6-21. Mixer/divider circuit etched-board assembly (P/N 1165-4014).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

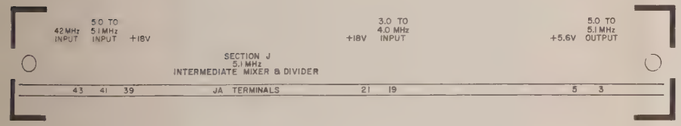
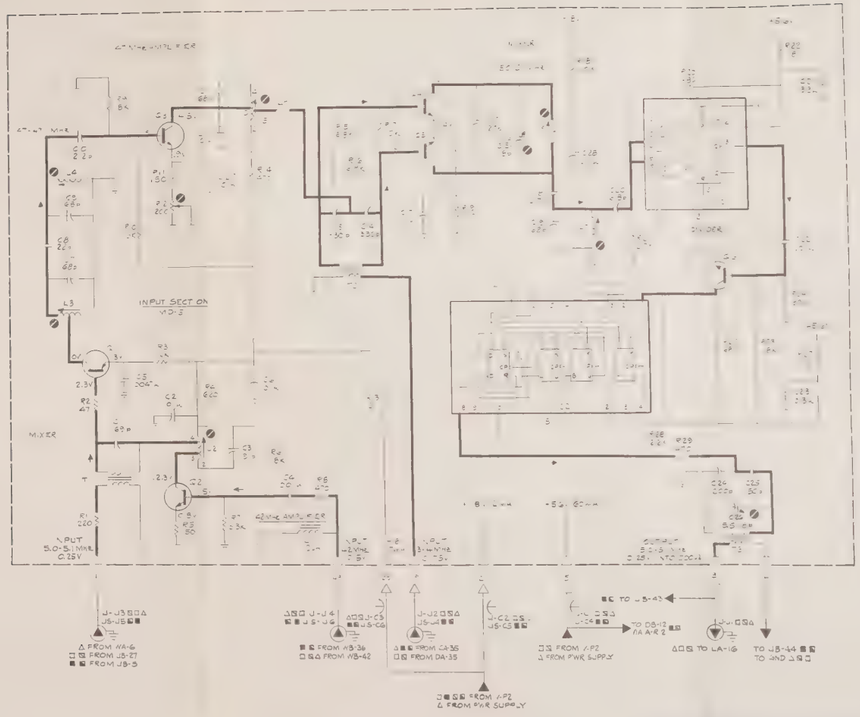


Figure 6-22. Bottom cover, exterior view, of section J.

MIXER/DIVIDER BOARD SCHEMATIC JA



SWITCH NUMBERING
FRONT REAR
CONTACTS FIRST CONTACT CW FROM STRIP BENCH ABOVE KEY 10 OR SECTION SECTION NEAREST PANEL 10
ROTOR SHOWN CW
CONNECTIONS
OUTPUT LEADS SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD.
ALL FEED-THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF

GROUND TERMINALS
1, 4, 6, 17, 18, 20, 22, 40, 42, 44

TRANSISTOR BASING (BOTTOM VIEW)

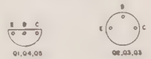


Figure 6-23. Section J.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4018 INPUT MIXER ASM (LA) (IM-47)					
CAPACITORS					
C1	Mica, 169 pF ±2%	4700-0443	14655	22A, 169 pF 2%	
C2	Ceramic, .01 µF +80-20%	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C3	Ceramic, 91 pF ±5%	4411-2000	72982	831, 91 pF 5%	
C4	Ceramic, .001 µF ±10%	4405-2108	72982	801, .001 µF 10%	5910-914-0087
C5	Ceramic, .0047 µF ±20%	4405-2470	72982	801, .0047 µF 20%	
C6	Ceramic, .01 µF ±5%	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C7	Ceramic, 68 pF ±5%	4413-1000	72982	0855037P2G00680J	
C8	Ceramic, .22 pF ±5%	4400-0022	78488	GA, .22 pF 5%	
C9	Ceramic, 68 pF ±5%	4413-1000	72982	0855037P2G00680J	
C10	Ceramic, 3.3 pF ±10%	4410-1200	72982	801, 3.3 pF 10%	
C11	Ceramic, 68 pF ±5%	4413-1000	72982	0855037P2G00680J	
C12	Ceramic, .01 µF ±2%	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C13	Ceramic, 68 pF ±5%	4413-1000	72982	0855037P2G00680J	
C14	Ceramic, .33 pF ±5%	4400-0033	78488	GA, .01 µF 2%	
C15	Ceramic, .01 µF ±2%	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
RESISTORS					
R1	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R2	Comp., 51 Ω ±5% 1/8 W	6098-0515	01121	BB, 51 Ω 5%	
R3	Comp., 1.2 kΩ ±5% 1/8 W	6098-2125	01121	BB, 1.2 kΩ 5%	
R4	Comp., 620 Ω ±5% 1/8 W	6098-1625	01121	BB, 620 Ω 5%	
R5	Comp., 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω 5%	5905-683-2243
R6	Comp., 18 kΩ ±5% 1/4 W	6099-3185	75042	BTS, 18 kΩ 5%	5905-687-0000
R7	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-9969
R8	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R9	Comp., 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ 5%	5905-688-3738
R10	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ 5%	5905-681-8818
R11	Comp., 120 Ω ±5% 1/4 W	6099-1125	75042	BTS, 120 Ω 5%	
R12	Pot. Comp., 200 Ω ±10%	6049-0293	01121	ZH2011	
R13	Comp., 51 Ω ±5% 1/8 W	6098-0515	01121	BB, 51 Ω 5%	
R14	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
INDUCTORS					
L1	Choke, molded 12 µH ±10%	4300-3050	99800	2150, 12 µH 10%	
L2	Choke, molded	1165-2405	24655	1165-2405	
L3	Choke, molded	1165-2410	24655	1165-2410	
L4	Choke, molded	1165-2415	24655	1165-2415	
L5	Choke, molded	1165-2410	24655	1165-2410	
L6	Choke, molded	1165-2425	24655	1165-2425	
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N3563	8210-1066	07263	2N3563	
Q3	Type 2N3563	8210-1066	07263	2N3563	
TRANSFORMER					
T1	Transformer	1160-2610	24655	1160-2610	

Figure 6-24. Input Mixer circuit etched-board assembly (P/N 1165-4018).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

Figure 6-25. Bottom cover, exterior view, of section L.

INPUT MIXER BOARD LA

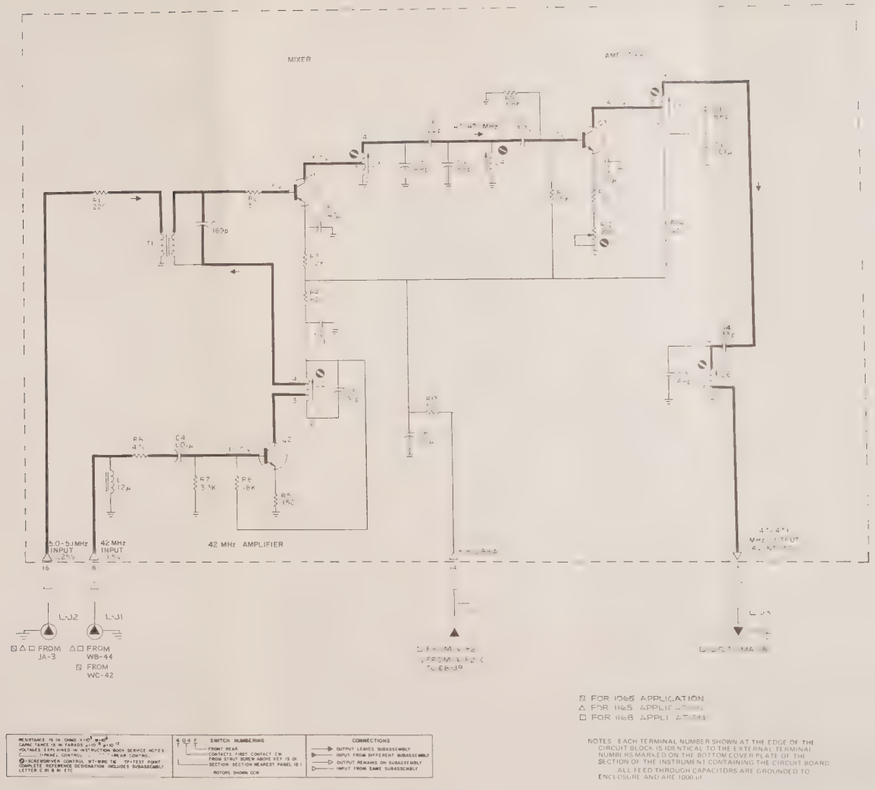

MIXER
42 MHz AMPLIFIER
5.0-5.1MHz INPUT +12V
42 MHz INPUT
LJ2
LJ1
FROM JA-3
FROM WB-44
FROM WC-42
FOR 1065 APPLICATION
FOR 1165 APPLICATION
FOR 1168 APPLICATION
NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBER MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD.
ALL FEED-THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF.

Figure 6-26. Section L.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4004 CIR. ASY. (DO3-1)					
CAPACITORS					
C1	Electrolytic, 47 µF +200 -10 V	4450-5712	56289	TT, 47 µF 20%	
C2	Ceramic, .27 pF ±5%	4417-0275	72982	801, .27 pF 5%	
C3	Ceramic, .27 pF ±5%	4417-0275	72982	801, .27 pF 5%	
C4	Ceramic, 180 pF ±5%	4404-1185	72982	831, 180 pF 5%	5910-952-8403
C5	Ceramic, .22 µF	4404-2224	80183	5C13, .22 µF 20%	5910-974-5694
C6	Ceramic, .0022 µF ±5% 200 V	4404-2222	80183	831, .0022 µF ±5% 200 V	
C7	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C8	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C9	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C10	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C11	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C12	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C13	Ceramic, .01 µF ±80-20% 100 V	4404-2100	80183	1,000 pF 20%	
C14	Ceramic, 56 pF ±5%	4404-1565	80183	1,000 pF 20%	
C15	Ceramic, 47 pF ±5%	4404-1475	80183	1,000 pF 20%	
C16	Ceramic, 100 pF ±5%	4404-1105	80183	1,000 pF 20%	
C17	Ceramic, 220 pF ±5%	4404-1225	80183	1,000 pF 20%	
C18	Ceramic, 75 pF ±5%	4404-1275	80183	1,000 pF 20%	
C19	Ceramic, 270 pF ±5%	4404-1245	80183	1,000 pF 20%	
C20	Trimmer, 7-25 pF	4410-2032	80183	538-000, 7 to 25 pF	5910-998-1621
DIODES					
CR1	Type MV1878	6084-1016	00434	MV1878	
CR2	Type MV1878	6084-1016	00434	MV1878	
CR3	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
FILTERS					
FL1		1165-0451	24655	1165-0451	
FL2		1165-0451	24655	1165-0451	
FL3		1165-0451	24655	1165-0451	
INDUCTORS					
L1	Choke, molded 3.3 µH	1165-2435	24655	1165-2435	
L2	Choke, molded 3.3 µH	4300-1401	99800	1537, 3.3 µH	
L3	Choke, molded .06 µH	4300-0505	99800	1537, .06 µH	
L4	Choke, molded .47 µH	4300-0475	99800	1537, .47 µH 10%	
L5	Choke, molded 100 µH	4300-2690	99800	1537, 100 µH	
INTEGRATED CIRCUITS					
U1	Digital	5431-9618	07263	SL14876	
RESISTORS					
R1	Comp., 56 Ω ±5% 1/4 W	6099-0105	75042	BTS, 10 Ω 5%	5905-809-8596
R2	Comp., 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ 5%	
R3	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R4	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R5	Comp., 33 Ω ±5% 1/4 W	6099-1335	75042	BTS, 33 kΩ 5%	
R6	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R7	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R8	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R9	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R10	Pot. Comp., 1 kΩ ±10%	6049-0292	01121	ZH1011	
R11	Pot. Comp., 500 Ω ±10%	6049-0293	01121	ZH2011	
R12	Pot. Comp., 500 Ω ±10%	6049-0293	01121	ZH2011	
R13	Pot. Comp., 500 Ω ±10%	6049-0293	01121	ZH5011	
R14	Pot. Comp., 500 Ω ±10%	6049-0294	01121	ZH5011	
R15	Pot. Comp., 1 kΩ ±10%	6049-0295	01121	ZH1021	
R16	Pot. Comp., 2 kΩ ±10%	6049-0296	01121	ZH2021	
R17	Pot. Comp., 5 kΩ ±10%	6049-0297	01121	ZH5021	
R18	Pot. Comp., 10 kΩ	6049-0298	01121	ZH1031	
R19	Comp., 200 Ω ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ 5%	5905-279-4629
R20	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2249
R21	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R22	Comp., 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω 5%	
R23	Comp., 430 Ω ±5% 1/4 W	6099-1435	75042	BTS, 430 Ω 5%	
R24	Comp., 510 Ω ±5% 1/4 W	6099-1515	75042	BTS, 510 Ω 5%	5905-801-8272
R25	Comp., 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
R26	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R27	Comp., 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ 5%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
R28	Comp., 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ 5%	5905-688-3738
R29	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R30	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R31	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R32	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R33	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R34	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R35	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R36	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R37	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R38	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R39	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R40	Comp., 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ 5%	5905-686-9998
R41	Comp., 27 Ω ±5% 1/8 W	6098-0275	01121	BB, 27 Ω 5%	
R42	Comp., 120 Ω ±5% 1/8 W	6098-1125	01121	BB, 120 Ω 5%	
R43	Comp., 120 Ω ±5% 1/8 W	6098-1125	01121	BB, 120 Ω 5%	
R44	Comp., 56 Ω ±5% 1/8 W	6098-0565	01121	BB, 56 Ω 5%	
R45	Comp., 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω 5%	
R46	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R47	Comp., 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 150 5%	
R48	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	
R49	Comp., 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
R50	Comp., 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ 5%	
R51	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R52	Comp., 15 Ω ±5% 1/4 W	6098-0155	01121	BB, 15 Ω 5%	
R53	Comp., 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
R54	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	5905-686-3369
R55	Comp., 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ 5%	5905-686-3368
TRANSFORMERS					
T1		5000-2402	24655	5000-2402	
TRANSISTORS					
Q1	Type 2N3563	8210-1066	07263	2N3563	
Q2	Type 2N5179	8210-1195	79089	2N5179	
Q3	Type 2N5179	8210-1195	79089	2N5179	
Q4	Type 2N4125	8210-1125	93916	2N4125	
Q5	Type 2N4125	8210-1125	93916	2N4125	
Q6	Type 2N4125	8210-1125	93916	2N4125	
Q7	Type 2N4125	8210-1125	93916	2N4125	
Q8	Type 2N4125	8210-1125	93916	2N4125	
Q9	Type 2N4125	8210-1125	93916	2N4125	
Q10	Type 2N4125	8210-1125	93916	2N4125	
Q11	Type 2N4125	8210-1125	93916	2N4125	
Q12	Type 2N4125	8210-1125	93916	2N4125	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4006 SAMPLER + DIV. CIR. (EB) (DO3-1)					
CAPACITORS					
C1	Ceramic, 15 pF ±5% 100 V	4410-1202	72982	811, 15 pF 5%	
C2	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C3	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C4	Ceramic, 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C5	Electrolytic, 1.0 µF ±20% 35 V	4450-4100	56289	150D105X0035A2	5910-726-5003
C6	Ceramic, .02 µF +80-20% 100 V	4402-3200	01121	35-203W	5910-952-8659
C7	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C8	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C9	Ceramic, 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C10	Ceramic, 1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF 20%	
C11	Ceramic, 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C12	Ceramic, 680 pF ±5% 500 V	4404-1685	72982	831, 685 pF 5%	
C14	Ceramic, 1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF 20%	5910-083-6445
C15	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C16	Ceramic, .001 µF ±5% 500 V	4405-2105	72982	801, .001 µF 5%	
C17	Ceramic, 180 pF ±5% 500 V	4404-1185	72982	831, 180 pF 5%	5910-952-8403
C18	Ceramic, .0022 µF ±5% 500 V	4406-2225	72982	811, .0022 µF 5%	5910-890-0668
C19	Ceramic, 75 pF ±5% 500 V	4404-0755	72982	831, 75 pF 5%	
C20	Ceramic, .0015 µF ±5% 500 V	4406-2155	72982	811, .0015 µF 5%	
CABLE					
Z1		1165-0320	24655	1165-0320	
DIODES					
CR1	A, B, C, D Type MSQ100520	6082-1023	13327	MSA100520	
CR5	Type MSD1041	6081-1024	13327	MSD-1041	
CR6	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR7	Type 1N995	6082-1002	80368	1N995	5961-893-6762
CR8	Type 1N995	6082-1002	80368	1N995	5961-893-6762
CR9	Type 1N995	6082-1002	80368	1N995	5961-893-6762
INDUCTORS					
L1	Choke, molded 22 µH ±10%	4300-2600	99800	1537, 22 µH 10%	5950-668-5867
L2	Choke, molded 1.5 µH ±10%	4300-1000	99800	1537, 1.5 µH 10%	
L3	Choke, molded 1.8 µH ±10%	4300-1100	99800	1537, 1.8 µH 10%	
L4	Choke, molded 1.8 µH ±10%	4300-1100	99800	1537, 1.8 µH 10%	
L5	Choke, molded 18 µH ±10%	4300-2500	99800	1537, 18 µH 10%	
INTEGRATED CIRCUITS					
IC1	Digital	5431-9613	82219	SF123	
IC2	Digital	5431-9613	82219	SF123	
RESISTORS					
R1	Comp., 51 Ω ±5% 1/8 W	6098-0515	01121	BB, 51 Ω 5%	
R2	Film, 49.9 Ω ±1% 1/8 W	6250-9499	75042	CEA, 49.9 Ω 1%	5905-800-7815
R3	Film, 49.9 Ω ±1% 1/8 W	6250-9499	75042	CEA, 49.9 Ω 1%	
R4	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R5	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R6	Comp., 100 Ω ±5% 1/8 W	6098-1105	01121	BB, 100 Ω 5%	
R7	Film, 27.4 kΩ ±1% 1/8 W	6250-2274	75042	CEA, 27.4 kΩ 1%	5905-702-0541
R8	Comp., 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ 5%	5905-682-4100
R9	Film, 27.4 kΩ ±1% 1/8 W	6250-2274	75042	CEA, 27.4 kΩ 1%	5905-702-0541
R10	Comp., 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ 5%	
R11	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R12	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R13	Comp., 1 kΩ ±10%	6049-0295	01121	ZH1021	
R14	Comp., 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ 5%	
R15	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R16	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 200 Ω 5%	5905-683-2240
R17	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R18	Pot. Comp., 2 kΩ ±10%	6049-0296	01121	ZH2021	
R19	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R20	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	5905-686-3369
R22	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R23	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	
R24	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R26	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-683-2238
R27	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-723-5251
R28	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-6462

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
R29	Comp., 82 Ω ±5% 1/4 W	6099-0825	75042	BTS, 82 Ω 5%	
R30	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R31	Comp., 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ 5%	5905-681-6465
R32	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R33	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R34	Comp., 4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω 5%	
R35	Pot. Comp., 100 Ω ±10%	6049-0292	01121	ZH1011	
TRANSFORMERS					
T1		5000-2403	24655	5000-2403	
T2		5000-2601	24655	5000-2601	
TRANSISTORS					
Q1	Type DN252	8210-1164	17856	DN252	
Q2	Type TD-400	8210-1169	56289	TD-400	
Q3	Type 2N3903	8210-1132	93916	2N3903	
Q4	Type 2N2369	8210-1052	93916	2N2369	5960-682-7755
Q5	Type 2N2369	8210-1052	93916	2N2369	5960-682-7755
Q6	Type 2N4125	8210-1125	93916	2N4125	
Q7	Type 2N4125	8210-1125	93916	2N4125	
Q8	Type 2N4275	8210-1126	23342	2N4275	

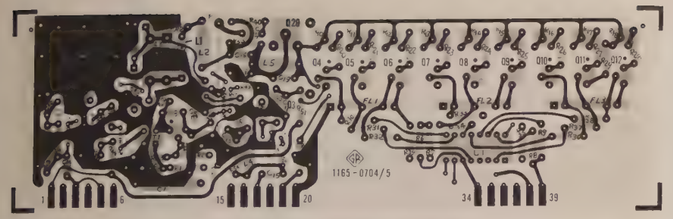


Figure 6-27. Oscillator circuit etched-board assembly (P/N 1165-4004).

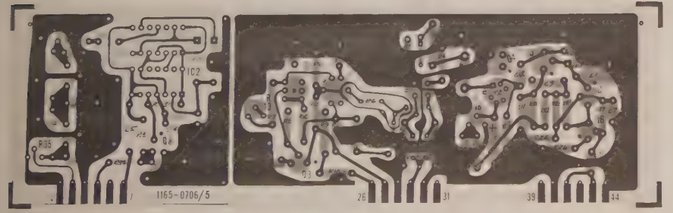


Figure 6-28. Sampler and divider etched-board assembly (P/N 1165-4006).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

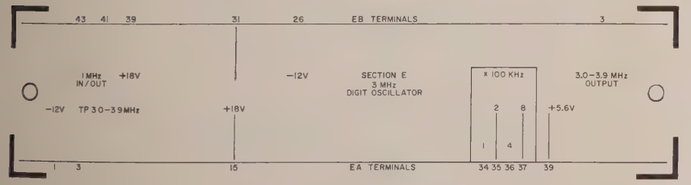


Figure 6-29. Bottom cover, exterior view, of section E.

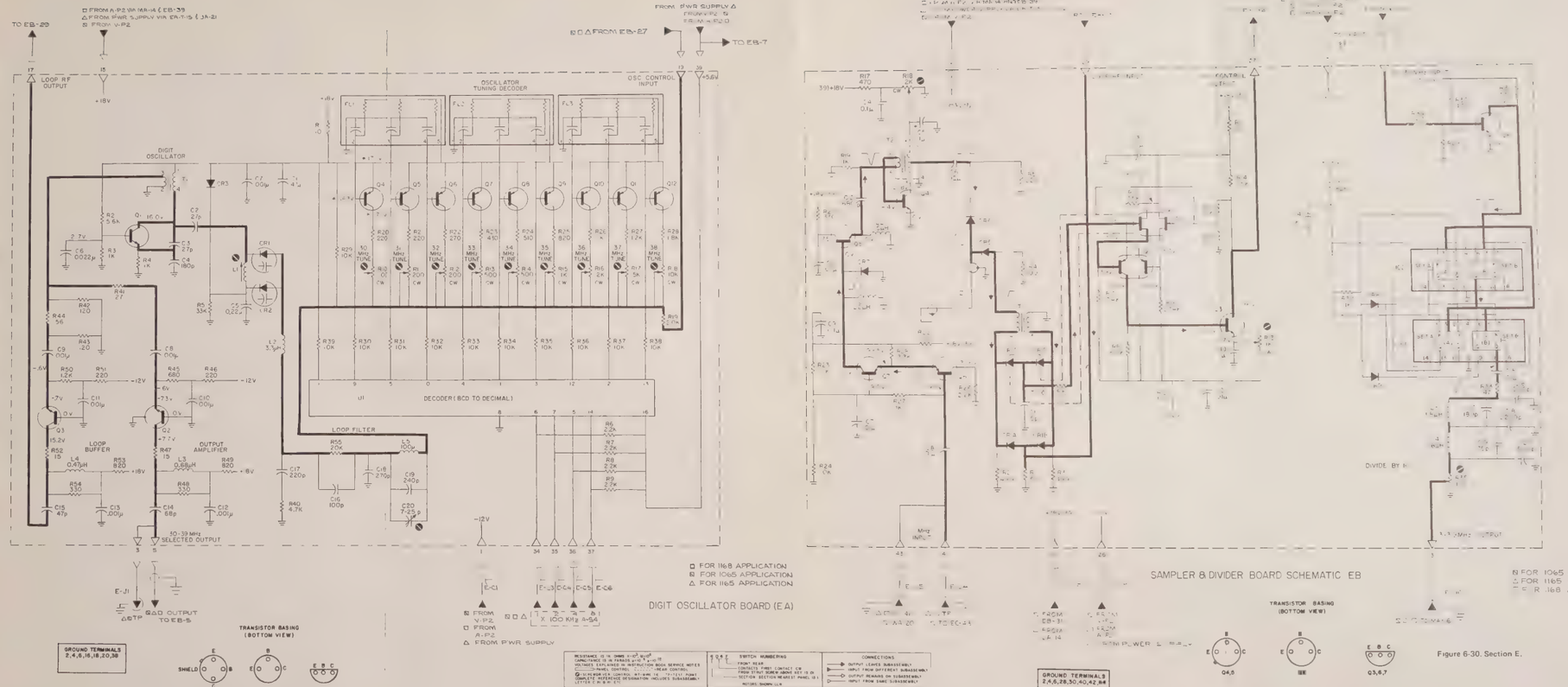


Figure 6-30. Section E.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4042 OUTPUT MIXER BOARD (MA) (IM-51)					
CAPACITORS					
C1	Ceramic, 68 pF ±5% 100 V	4411-2004	72982	831, 68 pF ±5%	
C2	Mica, 510 pF ±5% 300 V	4700-0613	14655	22A, 510 pF ±5%	
C3	Ceramic, 62 pF ±5% 100 V	4411-2002	72982	831, 62 pF ±5%	
C4	Ceramic, 5.1 pF ±5% 100 V	4410-1201	72982	811, 5.1 pF ±5%	
C5	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C6	Ceramic, 62 pF ±5% 100 V	4411-2002	72982	831, 62 pF ±5%	
C7	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C8	Ceramic, 1.8 pF ±5% 500 V	4400-0180	78488	GA, 1.8 pF ±5%	
C9	Ceramic, 62 pF ±5% 100 V	4411-2002	72982	831, 62 pF ±5%	
C10	Ceramic, 1.5 pF ±5% 500 V	4400-0150	78488	GA, 1.5 pF ±5%	
C11	Ceramic, 62 pF ±5% 100 V	4411-2002	72982	831, 62 pF ±5%	
INTEGRATED CIRCUITS					
IC1		5434-0101	23367	M6D	
RESISTORS					
R1	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R2	Comp. 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R3	Comp. 120 Ω ±5% 1/4 W	6099-1125	75042	BTS, 120 kΩ ±5%	
R4	Pot. Comp. 200 Ω ±10%	6049-0293	01121	ZH2011	
R5	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
TRANSISTORS					
Q1	Type 2N3478	8210-1111	12672	2N3478	
INDUCTORS					
L1		1165-2415	24655	1165-2415	
L2		1165-2415	24655	1165-2415	
L3		1165-2410	24655	1165-2410	
L4		1165-2415	24655	1165-2415	
L5		1165-2425	24655	1165-2425	

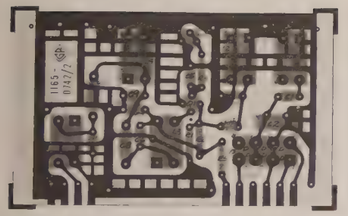


Figure 6-31. Output mixer circuit, etched-board, assembly (P/N 1165-4042).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

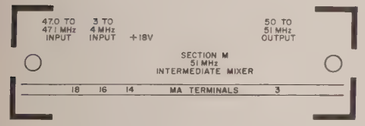
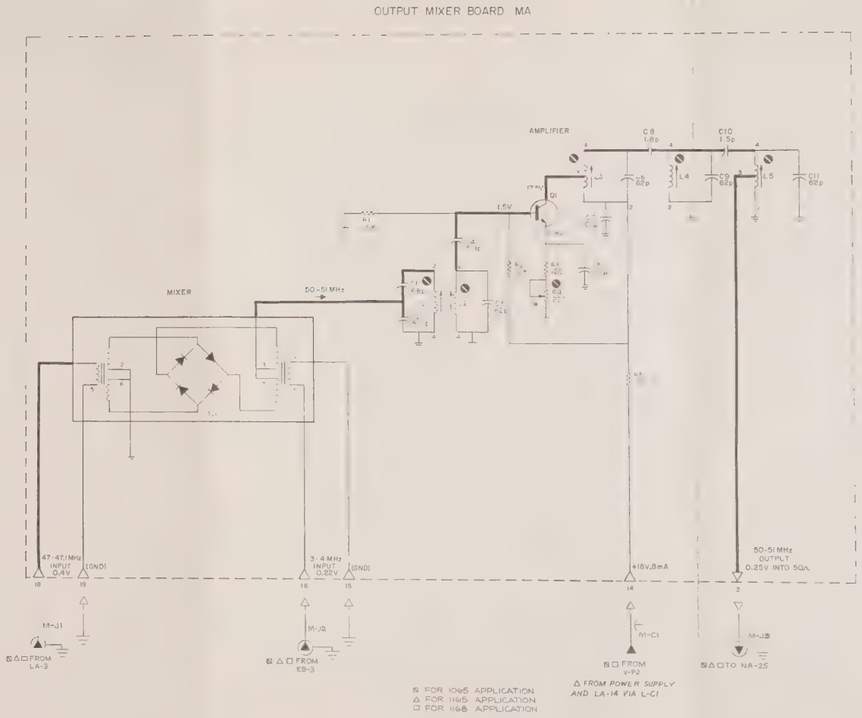
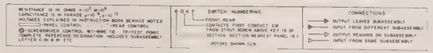


Figure 6-32. Bottom cover, exterior view, of section M.





NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD.
ALL FEED THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF

Figure 6-33. Section M.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No	Fed Stock No
1165-4004	CIR. (EA) DO30-1)				
CAPACITORS					
C1	Electrolytic, 47 µF +20% 20 V	4450-5712	37942	TT, 47 µF 20%	
C2	Ceramic, 27 pF ±5%	4417-0275	72982	801, 27 pF 5%	
C3	Ceramic, 27 pF ±5%	4417-0275	72982	801, 27 pF 5%	
C4	Ceramic, 180 pF ±5%	4404-1185	72982	831, 180 pF 5%	5910-952-8403
C5	Ceramic, .22 µF	4400-2052	80183	5C13, .22 µF 20%	5910-974-5694
C6	Ceramic, .0022 µF +80-20%	4404-2224	80183	831, .0022 µF +80-20%	
C7	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C8	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C9	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C10	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C11	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C12	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C13	Ceramic, .001 µF +20%	4404-2100	80183	1,,001 µF 20%	
C14	Ceramic, 68 pF ±5%	4404-0685	80183	68 pF 20%	
C15	Ceramic, 47 pF ±5%	4404-0475	80183	1, 47 pF 20%	
C16	Ceramic, 100 pF ±5%	4404-1105	80183	1, 100 pF 5%	
C17	Ceramic, 220 pF ±5%	4404-1225	80183	1, 220 pF 5%	
C18	Ceramic, 270 pF ±5%	4404-1278	80183	1, 270 pF 5%	
C19	Ceramic, 240 pF ±5%	4404-1245	80183	1, 240 pF 5%	
C20	Trimmer, 7-25 pF	4910-2032	80183	538-006, 7 to 25 pF	5910-998-1621
DIODES					
CR1	Type MV1878	6084-1016	00434	MV1878	
CR2	Type MV1878	6084-1016	00434	MV1878	
CR3	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
FILTERS					
FL1		1160-0451	24655	1160-0451	
FL2		1160-0451	24655	1160-0451	
FL3		1160-0451	24655	1160-0451	
INDUCTORS					
L1		1165-2435	24655	1165-2435	
L2	Choke, molded 3.3 µH	4300-1401	99800	1537, 3.3 µH	
L3	Choke, molded 0.68 µH	4300-0505	99800	1537, .68 µH	
L4	Choke, molded 0.47 µH	4300-0405	99800	1537, .47 µH 10%	
L5	Choke, molded 100 µH	4300-2690	99800	1537, 100 µH	
INTEGRATED CIRCUITS					
U1	Digital	5431-9618	07263	SL14876	
RESISTORS					
R1	Comp., 68 Ω ±5% 1/4 W	6099-0105	75042	BTS, 10 Ω 5%	5905-809-8596
R2	Comp., 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ 5%	
R3	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R4	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R5	Comp., 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ 5%	
R6	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R7	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R8	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R9	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R10	Pot. Comp., 100 Ω ±10%	6049-0292	01121	ZH1011	
R11	Pot. Comp., 200 Ω ±10%	6049-0293	01121	ZH2011	
R12	Pot. Comp., 200 Ω ±10%	6049-0293	01121	ZH2011	
R13	Pot. Comp., 500 Ω ±10%	6049-0294	01121	ZH5011	
R14	Pot. Comp., 500 Ω ±10%	6049-0294	01121	ZH5011	
R15	Pot. Comp., 1 kΩ ±10%	6049-0295	01121	ZH1021	
R16	Pot. Comp., 2 kΩ ±10%	6049-0296	01121	ZH2021	
R17	Pot. Comp., 5 kΩ ±10%	6049-0297	01121	ZH5021	
R18	Pot. Comp., 10 kΩ	6049-0298	01121	ZH1031	
R19	Comp., 20 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ 5%	5905-279-4629
R20	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2249
R21	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R22	Comp., 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω 5%	
R23	Comp., 430 Ω ±5% 1/4 W	6099-1435	75042	BTS, 430 Ω 5%	
R24	Comp., 510 Ω ±5% 1/4 W	6099-1515	75042	BTS, 510 Ω 5%	5905-801-8272
R25	Comp., 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
R26	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R27	Comp., 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ 5%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
R28	Comp., 1.8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1.8 kΩ 5%	5905-688-3738
R29	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R30	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R31	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R32	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R33	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R34	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R35	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R36	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R37	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R38	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R39	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R40	Comp., 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ 5%	5905-686-9998
R41	Comp., 27 Ω 5% 1/8 W	6098-0275	01121	BB, 27 Ω 5%	
R42	Comp., 120 Ω ±5% 1/8 W	6098-1125	01121	BB, 120 Ω 5%	
R43	Comp., 120 Ω ±5% 1/8 W	6098-1125	01121	BB, 120 Ω 5%	
R44	Comp., 56 Ω ±5% 1/8 W	6098-0565	01121	BB, 56 Ω 5%	
R45	Comp., 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω 5%	
R46	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R47	Comp., 15 Ω ±5% 1/4 W	6099-0155	75042	BTS, 15Ω 5%	
R48	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	
R49	Comp., 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
R50	Comp., 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ 5%	
R51	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R52	Comp., 15 Ω ±5% 1/4 W	6098-0155	01121	BB, 15 Ω 5%	
R53	Comp., 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
R54	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	5905-686-3369
R55	Comp., 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ 5%	5905-686-3368
TRANSFORMERS					
T1		5000-2402	24655	5000-2402	
TRANSISTORS					
Q1	Type 2N3563	8210-1066	07263	2N3563	
Q2	Type 2N5179	8210-1195	79089	2N5179	
Q3	Type 2N5179	8210-1195	79089	2N5179	
Q4	Type 2N4125	8210-1125	93916	2N4125	
Q5	Type 2N4125	8210-1125	93916	2N4125	
Q6	Type 2N4125	8210-1125	93916	2N4125	
Q7	Type 2N4125	8210-1125	93916	2N4125	
Q8	Type 2N4125	8210-1125	93916	2N4125	
Q9	Type 2N4125	8210-1125	93916	2N4125	
Q10	Type 2N4125	8210-1125	93916	2N4125	
Q11	Type 2N4125	8210-1125	93916	2N4125	
Q12	Type 2N4125	8210-1125	93916	2N4125	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4008	SAMPLER BOARD (EC) (DO-30-1)				
CAPACITORS					
C1	Ceramic, 15 pF ±5% 100 V	4410-1202	72982	811, 15 pF 5%	
C2	Ceramic, .01 µF +80-20% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C3	Ceramic, .01 µF +80-20% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C4	Ceramic, 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C5	Electrolytic, 1.0 µF ±20% 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C6	Ceramic, .02 µF +80-20% 100 V	4402-3200	01121	35-203W	5910-952-8659
C7	Ceramic, .01 µF +80-20% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C8	Ceramic, .01 µF +80-20% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
C9	Ceramic, 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C10	Ceramic, 1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF 20%	5910-083-6445
C11	Ceramic, 0.1 µF ±20% 25 V	4400-2050	80183	5C13, .1 µF 20%	5910-974-5695
C12	Ceramic, 680 pF ±5% 500 V	4404-1685	72982	831, 685 pF 5%	
RESISTORS					
R1	Comp., 51 Ω ±5% 1/8 W	6098-0515	01121	BB, 51 Ω 5%	
R2	Film, 49.9 Ω ±1% 1/8 W	6250-9499	75042	CEA, 49.9 Ω 1%	5905-800-7815
R3	Film, 49.9 Ω ±1% 1/8 W	6250-9499	75042	CEA, 49.9 Ω 1%	5905-800-7815
R4	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R5	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R6	Comp., 100 Ω ±5% 1/8 W	6098-1105	01121	BB, 100 Ω 5%	
R7	Film, 27.4 kΩ ±1% 1/8 W	6250-2274	75042	CEA, 27.4 kΩ 1%	5905-702-0541
R8	Comp., 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ 5%	5905-682-4100
R9	Film, 27.4 kΩ ±1% 1/8 W	6250-2274	75042	CEA, 27.4 kΩ 1%	5905-702-0541
R10	Comp., 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ 5%	5905-702-0541
R11	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R12	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R13	Pot. Comp., 1 kΩ ±10%	6049-0295	01121	ZH1021	
R14	Comp., 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ 5%	
R15	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R16	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 200 Ω 5%	5905-683-2240
R17	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R18	Pot. Comp., 2 kΩ ±10%	6049-0296	01121	ZH2021	
R19	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R20	Comp., 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω 5%	5905-686-3369
R22	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R23	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R24	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ 5%	5905-683-2238
R26	Comp., 2.2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2.2 kΩ 5%	5905-723-5251
R27	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R28	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ 5%	5905-681-9969
TRANSISTORS					
Q1	Type DN252	8210-1164	17856	DN252	
Q2	Type TD-400	8210-1169	56289	TD-400	
Q3	Type 2N3903	8210-1132	93916	2N3903	
Q4	Type 2N2369	8210-1052	93916	2N2369	5960-682-7755
Q5	Type 2N2369	8210-1052	93916	2N2369	
Q6	Type 2N4125	8210-1125	93916	2N4125	
Q7	Type 2N4125	8210-1125	93916	2N4125	
DIODES					
CR1A, B, C, D	Type MSQ100520	6082-1023	13327	MSA100520	
CR5	Type MSD1041	6082-1024	13327	MSD-1041	
CR6	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR7	Type 1N995	6082-1002	80368	1N995	
TRANSFORMERS					
T1		5000-2601	24655	5000-2601	
T2		5000-2403	24655	5000-2403	
INDUCTORS					
L1	Choke, molded 22 µH ±10%	4300-2600	99800	1537, 22 µH 10%	5950-668-5867
L2	Choke, molded 1.5 µH ±10%	4300-1000	99800	1537, 1.5 µH 10%	
CABLE					
Z1		1165-0320	24655	1165-0320	

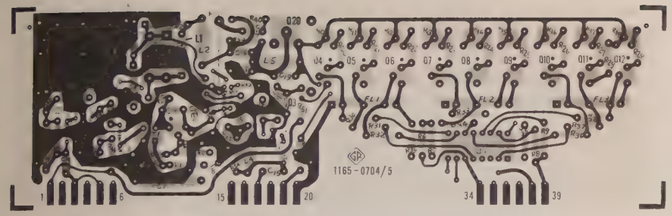


Figure 6-34. Oscillator circuit etched-board assembly (P/N 1165-4004).

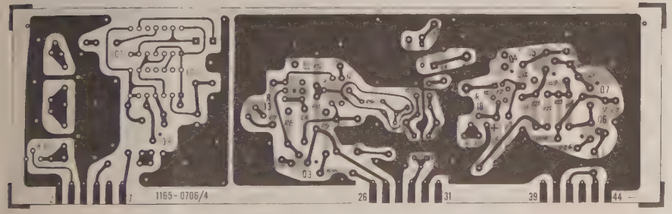


Figure 6-35. Sampler circuit etched-board assembly (P/N 1165-4008).

NOTE: The board *is* shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

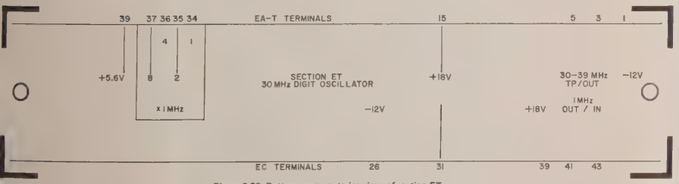
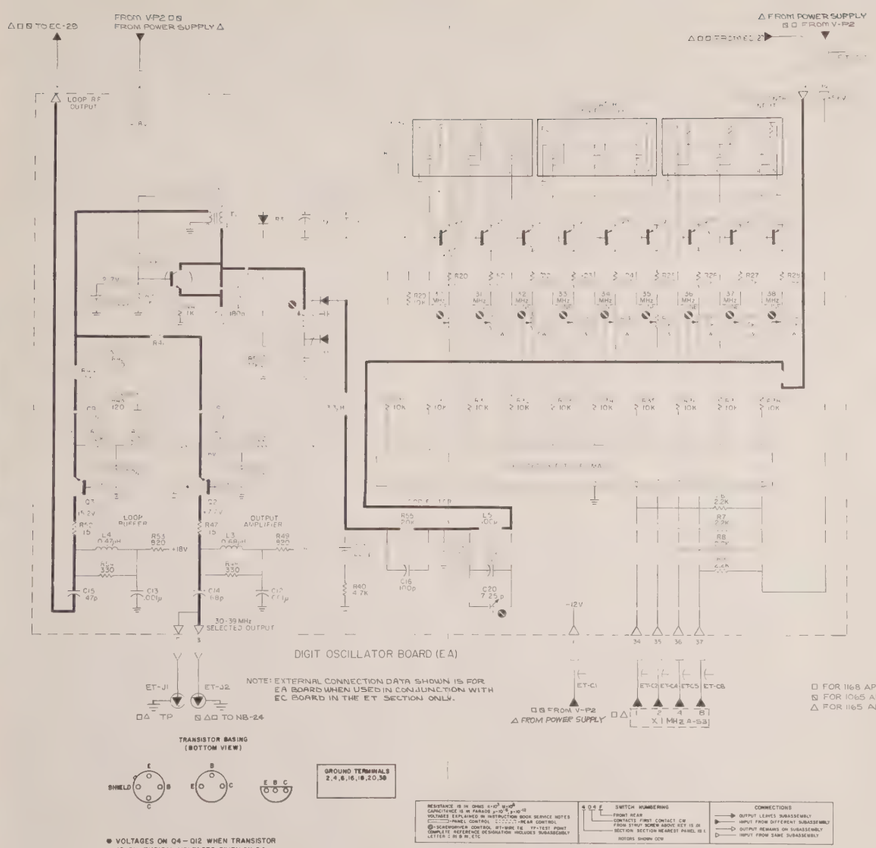


Figure 6-36. Bottom cover, exterior view, of section ET.


DIGIT OSCILLATOR BOARD (EA)
NOTE: EXTERNAL CONNECTION DATA SHOWN IS FOR EA BOARD WHEN USED IN CONJUNCTION WITH EC BOARD IN THE ET SECTION ONLY.
TRANSISTOR BASING (BOTTOM VIEW)
GROUND TERMINALS 2,4,6,16,18,20,38
● VOLTAGES ON Q4 – Q12 WHEN TRANSISTOR IS ON. TYPICAL VOLTAGES GIVEN ON Q4.

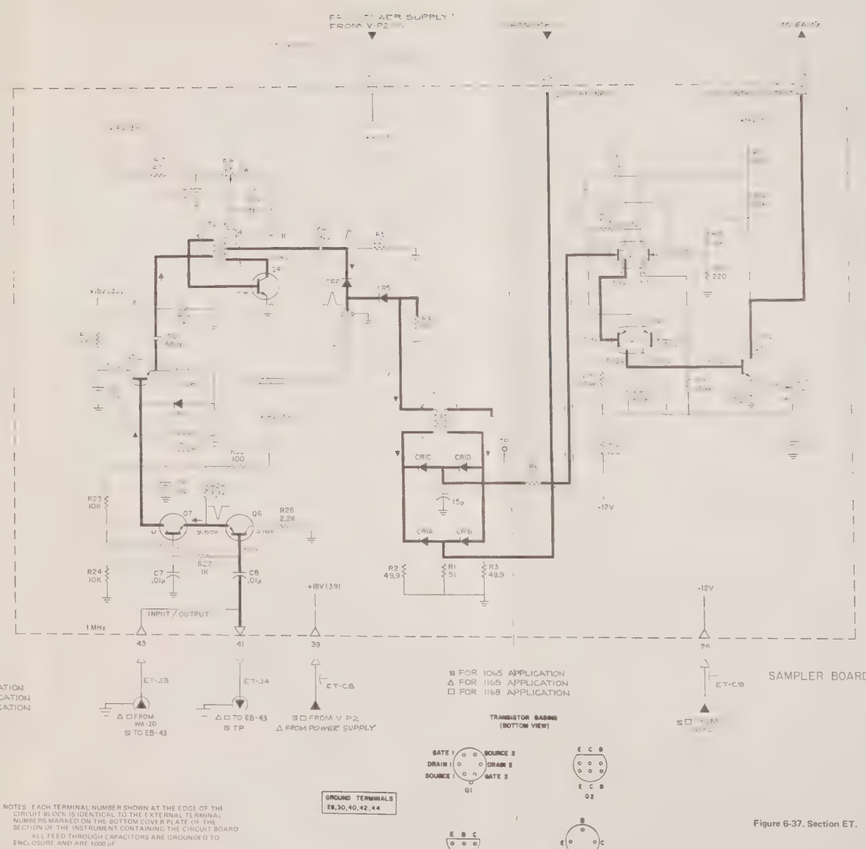


Figure 6-37. Section ET.

Ref Des	Description	GR Part No	Fed Mfg Code	Mfg Part No	Fed Stock No
	[illegible]				
	[illegible]				
C1	Ceramic .001 µF ±20% 500 V	4414-2108	72982	831-001-µF-20% 500 V	
C2	Ceramic .001 µF ±20% 500 V	4414-2108	72982	831-001-µF-20% 500 V	
C3	Ceramic .001 µF ±20% 500 V	4414-2108	72982	831-001-µF-20% 500 V	
C4	Ceramic .001 µF ±20% 500 V	4414-2108	72982	831-001-µF-20% 500 V	
C5	Ceramic .001 µF ±20% 500 V	4414-2108	72982	831-001-µF-20% 500 V	
C6	Ceramic .001 µF ±20% 500 V	4414-2108	72982	831-001-µF-20% 500 V	
C7	Ceramic 2.2 pF ±20% 500 V	4411-9825	72982	831-2.2pF-5%	
C8	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C9	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C10	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C11	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C12	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C13	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C14	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C15	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C16	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C17	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C18	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C19	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C20	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C21	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C22	Ceramic .001 µF +80-20% 500 V	4405-2105	72982	841-001 µF +80-20% 500 V	
C23	Ceramic 10 pF ±5% 500 V	4411-1825	72982	831-10pF-5%	
C24	Ceramic 10 pF ±5% 500 V	4411-1825	72982	831-10pF-5%	
	[illegible]				
D1	Type 1N4148	6084-1028	14433	BA141	
D2	Type 1N4148	6084-1028	14433	BA141	
D3	Type 1N2160A	6083-1011	07595	1N2160A	
D4	Type 1N625	6083-1060	75042	1N625	
	[illegible]				
L1	[illegible]	1165-2245	24655	1165-2245	
L2	[illegible]	1165-2245	24655	1165-2245	
L3	Choke, molded 1.89 µH ±10%	4300-7527	99800	1537-49	
L4	[illegible]	1165-2255	24655	1165-2255	
L5	[illegible]	1165-2255	24655	1165-2255	
L6	[illegible]	1165-2255	24655	1165-2255	

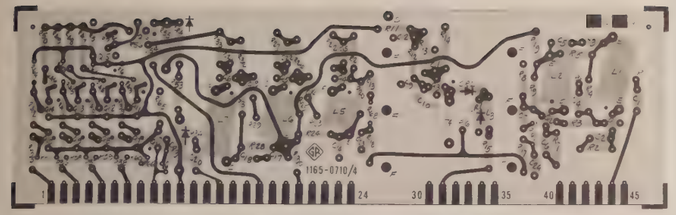


Figure 6-38. Oscillator circuit etched-board assembly (P/N 1165-4010).

Figure 6-39. Program circuit etched-board assembly (P/N 1165-4012).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

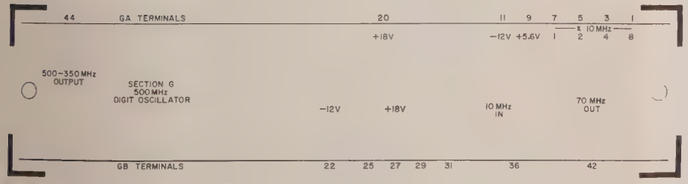
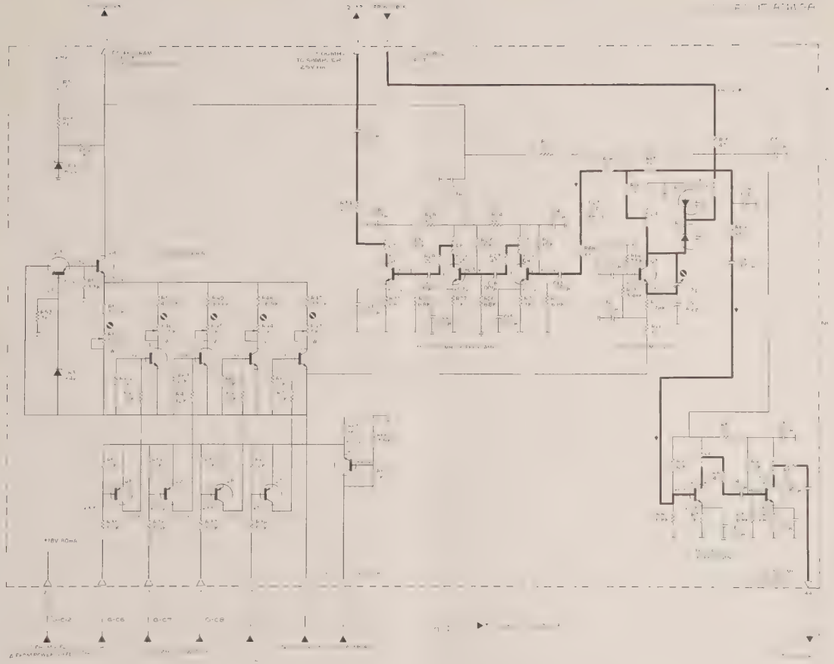


Figure 6-40. Bottom cover, exterior view, of section G.



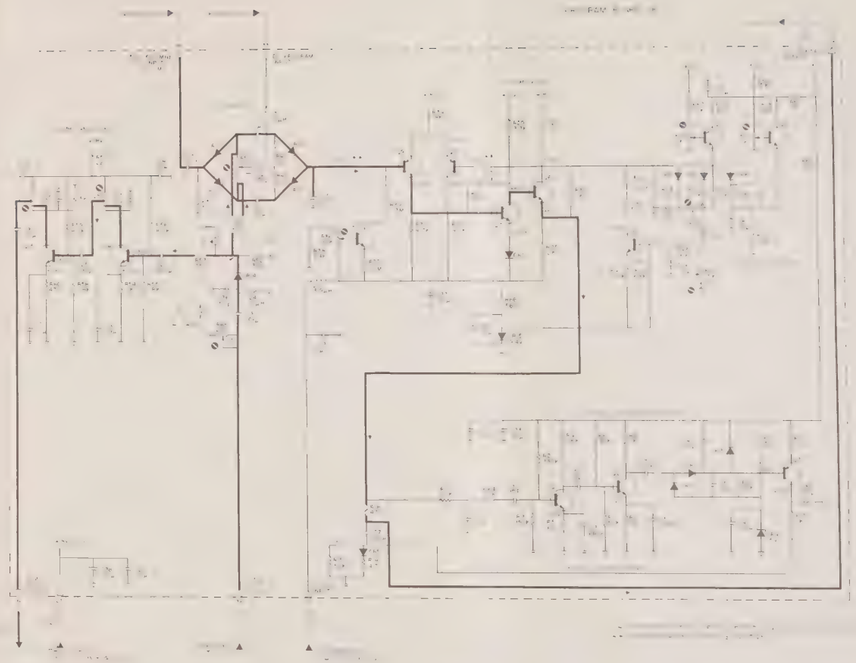


Figure 6-41. Section G.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4020 70 MHz CIRCUIT ASM. (PA) (PM - 420)					
CAPACITORS					
C1	Ceramic, 24 pF NO30 5% 100 V	4411-2006	72982	831, 24 pF NO30 5%	
C2	Ceramic, 1.0 pF 10% 500 V	4400-0100	78488	GA, 1 pF 10%	5910-981-3425
C3	Ceramic, 24 pF NO30 5% 100 V	4411-2006	72982	831, 24 pF NO30 5%	
C4	Ceramic, 7.5 pF N30 5% 500 V	4411-9755	72982	831, 7.5 pF N30 5%	
C5	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C6	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C7	Ceramic, 33 pF NPO 5% 500 V	4410-0335	72982	811, 33 pF NPO 5%	
C8	Ceramic, .001 µF +80-20% 500 V	4404-2109	72982	831, .001 µF +80-20%	5910-075-9607
C9	Ceramic, 24 pF NO30 5% 100 V	4411-2006	72982	831, 24 pF NO30 5%	
C10	Ceramic, 470 pF 5% 500 V	4404-1475	72982	831, 470 pF 5%	
C11	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C12	Ceramic, 47 pF 5% 500 V	4404-0475	72982	831, 47 pF 5%	
C14	Electrolytic, 6.8 µF 20% 35 V	4450-5000	56289	150D685X0035B2	5910-814-5869
RESISTORS					
R1	Comp., 470 Ω 5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R2	Comp., 22 Ω 5% 1/4 W	6099-0225	75042	BTS, 22 Ω 5%	5905-279-5459
R3	Comp., 82 Ω 5% 1/4 W	6099-0825	75042	BTS, 82 Ω 5%	
R4	Comp., 43 Ω 5% 1/4 W	6099-0435	75042	BTS, 43 Ω 5%	
R5	Comp., 100 Ω 5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R6	Comp., 12 kΩ 5% 1/4 W	6099-3125	75042	BTS, 12 kΩ 5%	
R7	Comp., 4.7 kΩ 5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ 5%	5905-686-9998
R8	Comp., 470 Ω 5% 1/4 W	6099-1475	75042	BTS, 470 Ω 5%	5905-683-2242
R9	Comp., 110 Ω 5% 1/4 W	6099-1115	75042	BTS, 110 Ω 5%	
R10	Comp., 100 Ω 5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R11	Comp., 1.1 kΩ 5% 1/4 W	6099-2115	75042	BTS, 1.1 kΩ 5%	
R12	Comp., 620 Ω 5% 1/4 W	6099-1625	75042	BTS, 620 Ω 5%	5905-801-6998
R13	Pot. Comp., 1 kΩ 10%	6049-0295	01121	ZH1021	
R14	Comp. 180 Ω 5% 1/4 W	6099-1185	75042	BTS, 820 Ω 5%	
R15	Comp., 2.4 kΩ 5% 1/4 W	6099-2245	75042	BTS, 2.4 kΩ 5%	5905-683-7724
R16	Comp., 1.2 kΩ 5% 1/4 W	6099-2125	75042	BTS, 1.2 kΩ 5%	
R17	Comp., 22 Ω 5% 1/4 W	6099-0225	75042	BTS, 22 Ω 5%	5905-279-5459
R18	Comp., 100 Ω 5% 1/4 W	6099-1105	75042	BTS, 100 Ω 5%	
R19	Comp., 1.5 kΩ 5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ 5%	
R20	Comp., 6.2 kΩ 5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ 5%	5905-682-4100
R21	Pot. Comp., 100 Ω 10%	6049-0292	01121	ZH1011	
R22	Pot. Comp., 200 Ω 10%	6049-0293	01121	ZH2011	
R23	Pot. Comp., 820 Ω 5% 1/4 W	6099-1825	75042	BTS, 820 Ω 5%	
TRANSISTORS					
Q1	Type 2N3478	8210-1111	12672	2N3478	
Q2	Type 2N3906	8210-1112	93916	2N3906	
Q3	Type 2N3903	8210-1132	93916	2N3903	
Q4	Type 2N3903	8210-1132	93916	2N3903	
DIODES					
CR1	Type 1N5148	6084-1016	00434	1N5148	
CR2	Type 1N748A	6083-1002	07910	1N748A	5960-800-3973
INDUCTORS					
L1	(BR)	1165-2200	24655	1165-2200	
L2	(RD)	1165-2205	24655	1165-2205	
L3	Choke, molded .39 µH ±10%	4300-7523	99800	1537, .39 µH 10%	
L4	Choke, molded .39 µH ±10%	4300-7523	99800	1537, .39 µH 10%	
L5	(OR)	1165-2210	24655	1165-2210	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4022 420 MHz CIRCUIT ASM. (PB) (PM - 420)					
CAPACITORS					
C1	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C2	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C3	Ceramic, 3.0 pF N30 5% 500 V	4411-0035	72982	831, 3.0 pF N30 5%	
C4	Air Dielectric 1.4-9.2 pF 10%	4380-3800	74970	189-503-105	
C5	Ceramic, 0.47 pF 10% 500 V	4400-1200	78488	GA, .47 pF 10%	
C6	Air Dielectric, 1.4-9 pF 10%	4380-3800	74970	189-503-105	
C8	Ceramic, 22 pF 10% 500 V	4404-0228	72982	831, 22 pF 10%	
C9	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C10	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C11	Trimmer, 1.0-4.5 pF	4910-1102	73899	VC10GWV	
C12	Ceramic, 470 pF 5% 500 V	4404-1475	72982	831, 470 pF 5%	
C13	Ceramic, 3.0 pF N30 5% 500 V	4411-0035	72982	831, 3.0 pF N30	
RESISTORS					
R1	Comp., 4.7 Ω 5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω 5%	
R2	Comp., 27 kΩ 5% 1/4 W	6099-3275	75042	BTS, 27 kΩ 5%	5905-683-3838
R3	Comp., 1 kΩ 5% 1/4 W	6099-2105	75042	BTS, 1 kΩ 5%	5905-681-6462
R4	Comp., 47 Ω 5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R5	Comp., 10 Ω 5% 1/8 W	6098-0105	01121	BB, 10 Ω 5%	
R6	Comp., 180 Ω 5% 1/4 W	6099-1185	75042	BTS, 180 Ω 5%	5905-279-5476
R7	Comp., 15 Ω 5% 1/8 W	6098-0155	01121	BB, 15 Ω 5%	
R8	Comp., 30 kΩ 5% 1/4 W	6099-3305	75042	BTS, 30 kΩ 5%	5905-803-2908
R9	Comp., 3.9 kΩ 5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ 5%	
R10	Comp., 47 Ω 5% 1/4 W	6099-0475	75042	BTS, 47 Ω 5%	
R11	Comp., 220 Ω 5% 1/4 W	6099-1225	75042	BTS, 220 Ω 5%	5905-683-2240
R12	Comp., 10 Ω 5% 1/8 W	6098-0105	01121	BB, 10 Ω 5%	
TRANSISTORS					
Q1	Type 2N3478	8210-1111	12672	2N3478	
Q2	Type A485	8210-1194	73445	A485	
INDUCTORS					
L1	YE	1165-2215	24655	1165-2215	
L2	GN	1165-2225	24655	1165-2225	
L3	OR	1165-8185	24655	1165-8185	

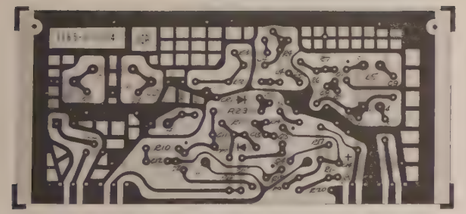


Figure 6-42. 70-MHz circuit etched-board assembly (P/N 1165-4020).

Figure 6-43. 420-MHz circuit etched-board assembly (P/N 1165-4022).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

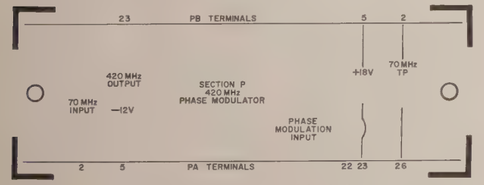
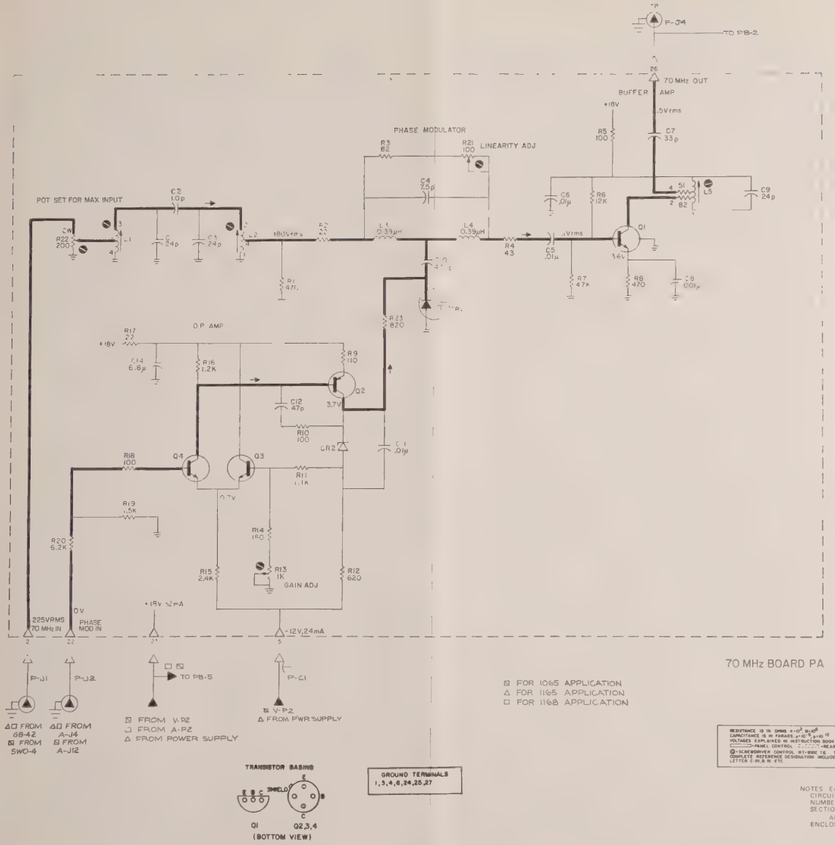
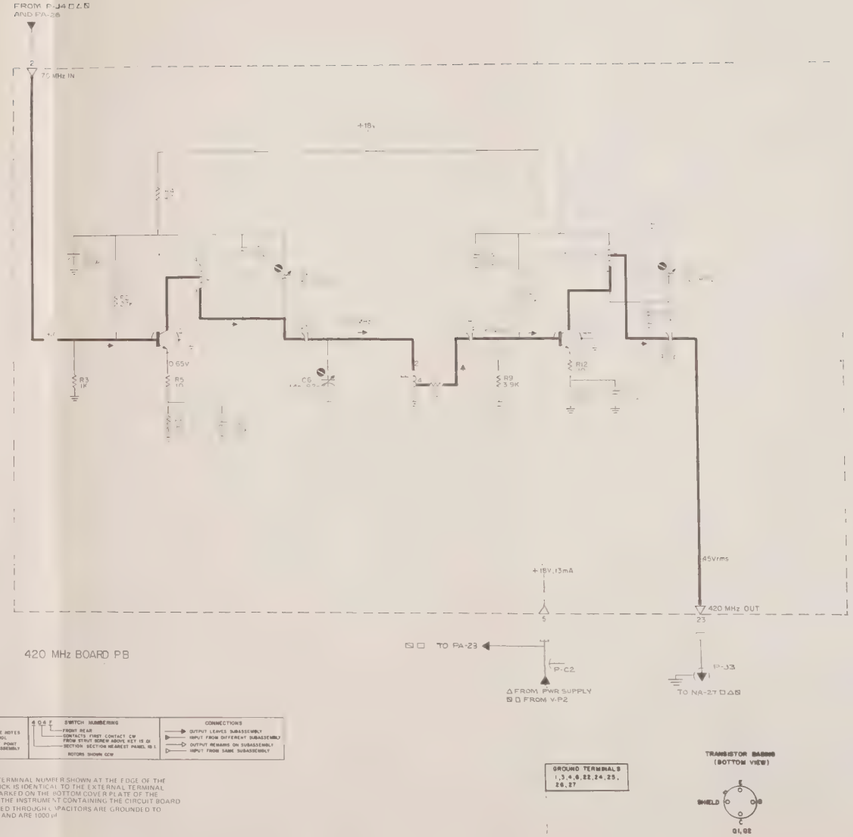


Figure 6-44. Bottom cover, exterior view, of section P.



70 MHz BOARD PA

FOR 1065 APPLICATION
FOR 1165 APPLICATION
FOR 1168 APPLICATION



420 MHz BOARD PB

FOR 1065 APPLICATION
FOR 1165 APPLICATION
FOR 1168 APPLICATION

RESISTANCE IS IN OHMS, K=10³, M=10⁶
CAPACITANCE IS IN FARADS, μ=10⁻⁶, p=10⁻¹²
VOLTAGES EXPLAINED IN INSTRUCTION BOOK SERVICE NOTES
SEE SECTION OF INSTRUMENT CONTAINING HEAD CONTROL
SCREWDRIVER CONTROL, RT=RMS DC CIRCUIT POINT
COMPLETE REFERENCE DESIGNATION INCLUDES SUBASSEMBLY LETTER C-M,S,W ETC

SWITCH NUMBERING
FRONT REAR
CONTACTS FIRST CONTACT CW FROM STRUT SCREW ABOVE KEY 10 IS BOTTOM SECTION NEAREST PANEL NO 1
ROTORS SHOWN CCW

CONNECTORS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD
ALL FEED THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pf

Figure 6-45. Section P.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4024 470 MHz BOARD (NA) (IM - 510)					
CAPACITORS					
C1	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C2	Ceramic, 100 pF ±10% 500 V	4404-1108	72982	831, 100 pF 10%	
C3	Ceramic, .001 µF +80-20% 500 V	4404-2109	72982	831, .001 µF +80-20%	5910-075-9607
C4	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C5	Ceramic, 20 pF ±5% 500 V	4410-0205	02982	801 20 pF 5%	
C6	Trimmer, 1.0-4.5 pF	4910-1102	73899	VC10GWY	
INTEGRATED CIRCUITS					
U1		5434-0100	23367	M6F	
RESISTORS					
R1	Comp., 2.2 kΩ ±5% 1/8 W	6098-2225	01121	BB, 2.2 kΩ 5%	
R2	Comp., 1.8 kΩ ±5% 1/8 W	6098-2185	01121	BB, 1.8 kΩ 5%	
R3	Comp., 68 Ω ±5% 1/8 W	6098-0685	01121	BB, 68 Ω 5%	
R4	Comp., 820 Ω ±5% 1/8 W	6098-1825	01121	BB, 820 5%	
R5	Pot. Comp., 1 kΩ ±10%	6049-0295	01121	ZH1021	
R6	Comp., 100 Ω ±5% 1/8 W	6098-1105	01121	BB, 100 Ω 5%	
R7	Comp., 10 Ω ±5% 1/8 W	6098-0105	01121	BB, 10 Ω 5%	
R8	Comp., 330 Ω ±5% 1/8 W	6098-1335	01121	BB, 330 Ω 5%	
R9	Comp., 10 Ω ±5% 1/8 W	6098-0105	01121	BB, 10 Ω 5%	
R10	Comp., 39 Ω ±5% 1/8 W	6098-0395	01121	BB, 39 Ω 5%	
R11	Comp., 10 Ω ±5% 1/8 W	6098-0105	01121	BB, 10 Ω 5%	
TRANSISTORS					
Q1	Type 2N3478	8210-1111	12672	2N3478	
Q2	Type 2N3478	8210-1111	12672	2N3478	
INDUCTOR					
L1		1165-8008	24655	1165-8008	
FILTER					
FL1		1165-2621	24655	1165-2621	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4026 500 MHz BOARD (NB)					
CAPACITORS					
C1	Ceramic, 56 pF +80-20% 500 V	4404-0565	72982	831, 56 pF +80-20%	
C2	Ceramic, .001 µF +80-20% 500 V	4404-2109	72982	831, .001 µF +80-20%	5910-075-9607
C3	Ceramic, 20 pF ±5% 500 V	4410-0205	72982	801, 20 pF 5%	
C4	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
C5	Trimmer, 1.0-4.5 pF	4910-1102	73899	VC10GWY	
C7	Ceramic, .001 µF +100-0 300 V	4400-5700	00656	BC-C1-2-NM	
INTEGRATED CIRCUITS					
U1		5434-0100	23367	M6F	
RESISTORS					
R1	Comp., 2.2 kΩ ±5% 1/8 W	6098-2225	01121	BB, 2.2 kΩ 5%	
R2	Comp., 1.8 kΩ ±5% 1/8 W	6098-2185	01121	BB, 1.8 kΩ 5%	
R3	Comp., 68 Ω ±5% 1/8 W	6098-0685	01121	BB, 68 Ω 5%	
R4	Comp., 220 Ω ±5% 1/8 W	6098-1225	01121	BB, 220 Ω 5%	
R5	Pot. Comp., 1 kΩ ±10%	6049-0295	01121	ZH1021	
R6	Comp., 100 Ω ±5% 1/8 W	6098-1105	01121	BB, 100 Ω 5%	
R7	Comp., 27 Ω ±5% 1/8 W	6098-0275	01121	BB, 27 Ω 5%	
R8	Comp., 330 Ω ±5% 1/8 W	6098-1335	01121	BB, 330 Ω 5%	
R9	Comp., 10 Ω ±5% 1/8 W	6098-0105	01121	BB, 10 Ω 5%	
R10	Comp., 82 Ω ±5% 1/8 W	6098-0825	01121	BB, 82 Ω 5%	
R11	Comp., 27 Ω ±5% 1/8 W	6098-0275	01121	BB, 27 Ω 5%	
R12	Comp., 82 Ω ±5% 1/8 W	6098-0825	01121	BB, 82 Ω 5%	
TRANSISTORS					
Q1	Type 2N3478	8210-1111	12672	2N3478	
Q2	Type 2N3478	8210-1111	12672	2N3478	
INDUCTORS					
L1		1165-8008	24655	1165-8008	
L2	.56 µH ±10%	4300-7521	99800	1025-14, .56 µH 10%	
FILTERS					
FL1		1165-2631	24655	1165-2631	

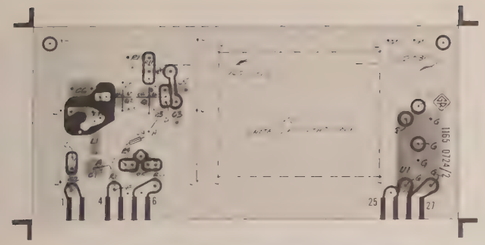


Figure 6-46. 470-MHz circuit etched-board assembly (P/N 1165-4024).

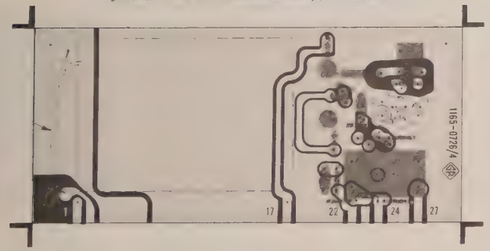


Figure 6-47. 500-MHz circuit etched-board assembly (P/N 1165-4026).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

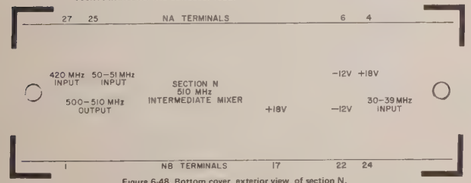
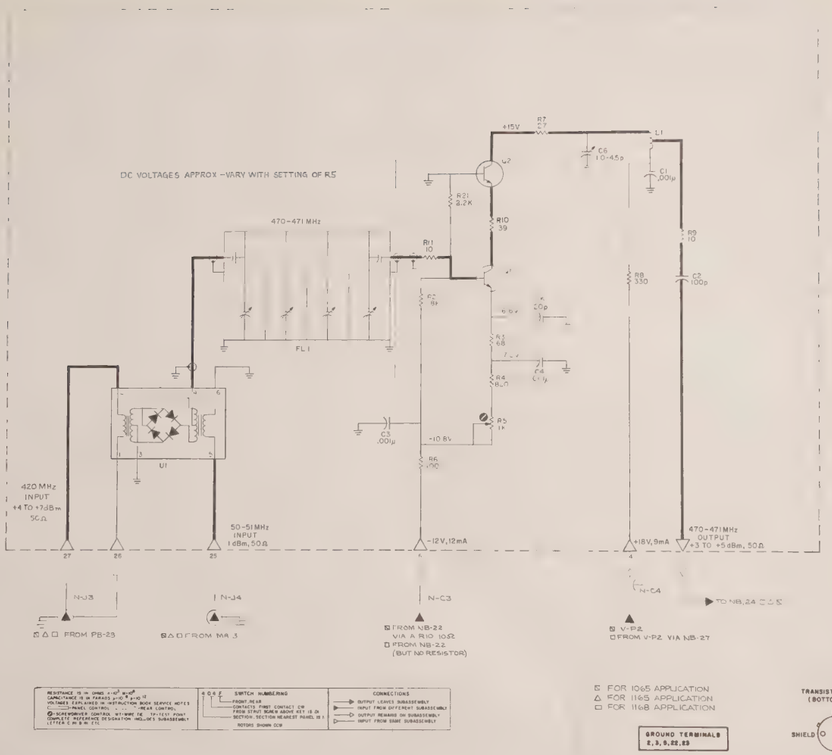


Figure 6-48. Bottom cover, exterior view, of section N.

470 MHz BOARD NA



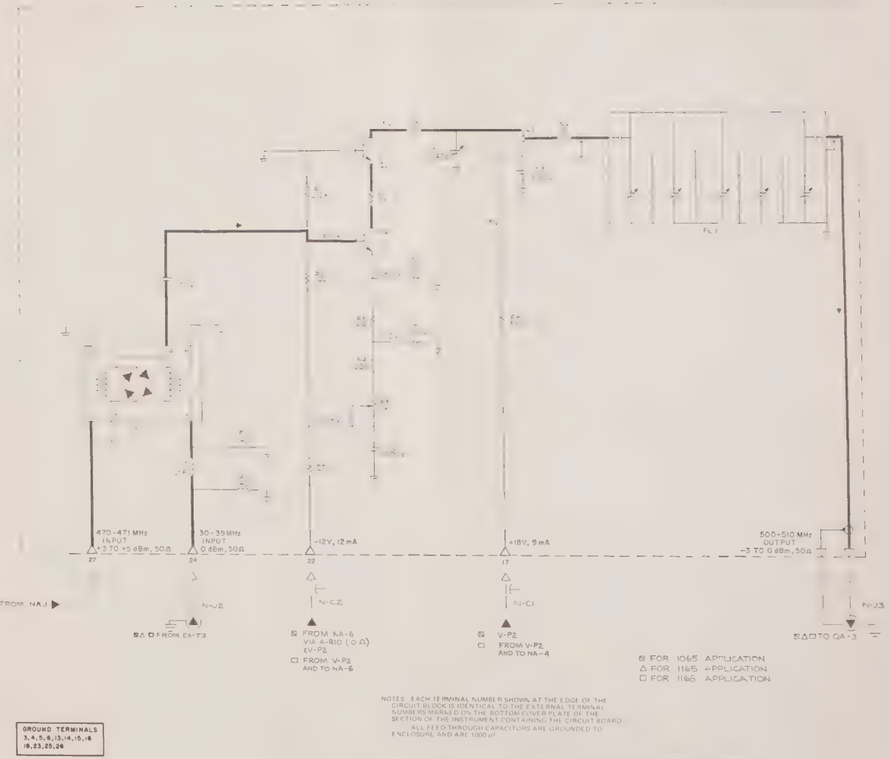
5 FOR 1065 APPLICATION
△ FOR 1165 APPLICATION
□ FOR 1168 APPLICATION

GROUND TERMINALS 2, 3, 5, 22, 23

TRANSISTOR BASING (BOTTOM VIEW)

GROUND TERMINALS 3, 4, 5, 6, 13, 14, 15, 16 19, 23, 25, 26

500 MHz BOARD NB



5 FOR 1065 APPLICATION
△ FOR 1165 APPLICATION
□ FOR 1166 APPLICATION

NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD.
ALL FEED-THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF.

Figure 6-49. Section N.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No	Fed Mfg Code	Mfg Part No	Fed Stock No
1165-4028 MIXER BOARD (A) (DMA - 28B)					
CAPACITORS					
C1		4434-1475	72982	831, 470 pF ±5%	
C2		4434-[illegible]	[illegible]	BC-CJ-2-NM	
C3		4434-[illegible]	[illegible]	BC-CJ-2-NM	
C4		4400-0122	72982	VC1, 4 W	
C5		4434-1475	72982	831, 470 pF ±5%	
C6		4434-1185	72982	831, 11 pF ±5%	
C7		4434-1185	72982	831, 15 pF ±5%	
C8		4434-1185	72982	831, 15 pF ±5%	
C9		4411-2055	72982	831, 4.7 pF ±5%	
C10		4434-[illegible]	72982	831, 1 pF ±5%	5910-974-5695
C11		4431-[illegible]	56289	150D106X9020B2	5910-855-6343
C12		4411-2055	72982	831, 4.7 pF ±5%	
C13		4434-4080	56289	5C13, .1 µF +80-20%	5910-936-1332
C14		4400-[illegible]	56289	5C13, .1 µF +80-20%	5910-974-5695
C15		4431-[illegible]	56289	150D106X9020B2	5910-855-6343
C16		4434-4080	56289	5C13, .22 µF +80-20%	
C17		4434-[illegible]	56289	5C13, .1 µF +80-20%	5910-974-5695
C18		4431-[illegible]	56289	150D106X9020B2	5910-855-6343
C19		4434-[illegible]	56289	5C13, .1 µF +80-20%	5910-974-5695
C20		4434-[illegible]	56289	5C13, .1 µF +80-20%	5910-936-1332
C21		4434-[illegible]	56289	5C13, .1 µF +80-20%	5910-974-5695
C22		4434-[illegible]	56289	5C13, .1 µF +80-20%	5910-936-1332
C23		4431-[illegible]	56289	150D106X9020B2	5910-855-6343
C24		4434-[illegible]	56289	5C13, .1 µF +80-20%	5910-936-1332
C25		4431-[illegible]	56289	150D106X9020B2	5910-855-6343
C26		4434-[illegible]	72982	831, 470 pF ±5%	
C27		4400-[illegible]	72982	VC1, 4 W	
C28		4434-[illegible]	72982	831, 470 pF ±5%	
INTEGRATED CIRCUITS					
U1		5434-1160	24655	M6F	
RESISTORS					
R1		4000-1475	75042	BTS, 4.7 kΩ ±5%	
R2		4000-1195	75042	BTS, 390 Ω ±5%	
R3		4000-2155	75042	BTS, 1.5 kΩ ±5%	
R4		4000-1545	75042	BTS, 510 Ω ±5%	5905-681-8272
R5		4000-1245	75042	BTS, 240 Ω ±5%	
R6		4000-1025	01121	BB, 22 Ω ±5%	
R7		4000-1025	01121	BB, 22 Ω ±5%	
R8		4000-1475	01121	BB, 47 Ω ±5%	
R9		4000-1045	01121	BB, 1 Ω	
R10		4000-1065	01121	BB, 10 Ω	
R11		4000-1185	01121	BB, 150 Ω ±5%	
R12		4000-1475	75042	BTS, 4.7 Ω ±5%	
R13		4000-1115	75042	BTS, 1.1 kΩ ±5%	
R14		4000-1165	75042	BTS, 1.6 kΩ ±5%	
R15		4000-2475	75042	BTS, 4.7 kΩ ±5%	5905-688-9998
R16		4000-1595	75042	BTS, 5.9 Ω ±5%	
R17		4000-1365	75042	BTS, 360 Ω ±5%	5905-681-2240
R18		4000-1225	75042	BTS, 220 Ω ±5%	5905-688-9993
R19		4000-1125	75042	BTS, 120 Ω ±5%	5905-681-6462
R20		4000-1245	75042	BTS, 240 Ω ±5%	
R21		4000-2435	75042	BTS, 24 kΩ ±5%	
R22		4000-1035	75042	BTS, 10 Ω ±5%	
R23		4000-2335	75042	BTS, 33 kΩ ±5%	5905-688-3358
R24		4000-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R25		4000-1075	75042	BTS, 27 Ω ±5%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4028 MIXER BOARD					
R26	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R27	Comp. 180 kΩ ±5% 1/4 W	6099-4185	75042	BTS, 180 kΩ ±5%	
R28	Comp. 16 kΩ ±5% 1/4 W	6099-3165	75042	BTS, 16 kΩ ±5%	
R29	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R30	Comp. 43 kΩ ±5% 1/4 W	6099-3435	75042	BTS, 43 kΩ ±5%	5905-549-9833
R31	Comp. 39 kΩ ±5% 1/4 W	6099-3395	75042	BTS, 39 kΩ ±5%	5905-686-3358
R32	Comp. 180 Ω ±5% 1/4 W	6099-1185	75042	BTS, 180 Ω ±5%	5905-279-5476
R33	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R34	Comp. 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R35	Comp. 1.1 kΩ ±5% 1/4 W	6099-2115	75042	BTS, 1.1 kΩ ±5%	
R36	Comp. 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R37	Comp. 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R38	Comp. 39 Ω ±5% 1/4 W	6099-0395	75042	BTS, 39 Ω ±5%	
R39	Comp. 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-829-0107
R40	Pot. Comp. 2 kΩ ±10%	6049-0296	01121	ZH2021	
R41	Comp. 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R42	Comp. 270 Ω ±5% 1/4 W	6099-1275	75042	BTS, 270 Ω ±5%	
R43	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R44	Comp. 360 Ω ±5% 1/4 W	6099-1365	75042	BTS, 360 Ω ±5%	
R45	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R46	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R47	Comp. 200 Ω ±5% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-892-0107
R48	Comp. 22 Ω ±5% 1/4 W	6099-0225	75042	BTS, 22 Ω ±5%	5905-279-5459
R49	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R50	Comp. 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R51	Comp. 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R52	Comp. 24 Ω ±5% 1/4 W	6099-0245	75042	BTS, 24 Ω ±5%	
R53	Comp. 68 Ω ±5% 1/4 W	6099-0685	75042	BTS, 68 Ω ±5%	
R54	Comp. 10 Ω ±5% 1/8 W	6098-0105	01121	BB, 10 Ω ±5%	
TRANSISTORS					
Q1	Type A485	8210-1194	73445	A485	
Q2	Type 2N3478	8210-1111	12672	2N3478	
Q3	Type 40673	8210-1193	56289	3N159	
Q4	Type 40673	8210-1193	56289	3N159	
Q5	Type 2N3478	8210-1111	12672	2N3478	
Q6	Type 2N3478	8210-1111	12672	2N3478	
Q7	Type 2N5109	8210-1198	79089	2N5109	
INDUCTORS					
L1		1165-8185	24655	1165-8185	
L2		1165-8186	24655	1165-8186	
L3		1165-8187	24655	1165-8187	
L4	Choke, molded .15 µH ±10%	4300-7553	99800	1537, .15 µH ±10%	
L5	Choke, molded .15 µH ±10%	4300-7553	99800	1537, .15 µH ±10%	
L6	Choke, molded .18 µH ±10%	4300-7554	99800	1537, .18 µH ±10%	
L7		1165-8185	24655	1165-8185	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4030 AMPLIFIER BOARD (QB) (DMA - 16D)					
CAPACITORS					
C1	Ceramic, 2.2 µF ±20% 50 V	4400-6420	72982	8141-050-651-225M	
C2	Ceramic, 2.2 µF ±20% 50 V	4400-6420	72982	8141-050-651-225M	
C3	Ceramic, 100 pF ±5% 500 V	4404-1105	72982	831, 100 pF ±5%	5910-952-8403
C4	Ceramic, 3.3 µF ±20% 25 V	4400-2082	80183	5C13, 3.3 µF ±20%	
C5	Ceramic, 100 pF ±5% 500 V	4404-1105	72982	831, 100 pF ±5%	5910-952-8403
C7	Electrolytic, 10 µF ±20% 20 V	4450-5100	56289	150D106X0020B2	5910-855-6343
C8	Electrolytic, 10 µF ±20% 20 V	4450-5100	56289	150D106X0020B2	5910-855-6343
C9	Ceramic, 2.2 pF ±20% 50 V	4400-6420	72982	8141-050-651-225M	
C10	Ceramic, 47 pF ±5% 500 V	4404-0475	72982	831, 33 pF ±5%	
C11	Electrolytic, 6.8 µF +20% 6 V	4450-4800	56289	150D685X0010A2	5910-936-1332
C12	Ceramic, .01 µF ±10% 50 V	4400-6351	72982	8121-050-W5R-103K	
C13	Ceramic, 1.0 µF ±20% 25 V	4400-2070	80183	5C13, 1 µF ±20%	5910-083-6445
C14	Ceramic, .01 µF ±10% 50 V	4400-6350	72982	8121-050-W5R-103K	
C15	Electrolytic, 10 µF ±20% 20 V	4450-5100	56289	150D106X0020B2	5910-855-6343
C16	Ceramic, .22 µF ±20% 25 V	4400-2052	80183	5C13, .22 µF ±20%	5910-974-5694
C17	Ceramic, .22 µF ±10% 50 V	4400-6352	72982	8131-050-W5R-224K	
C18	Electrolytic, 10 µF ±20% 20 V	4450-5100	56289	150D106X0020B2	5910-855-6343
C19	Electrolytic, 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C20	Electrolytic, 22 µF +20% 15 V	4450-5300	56289	150D226X0015B2	5910-752-4270
C21	Ceramic, .01 µF +80-20% 100 V	4401-3100	80183	CC61, .01 µF +80-20%	5910-974-5697
INDUCTOR					
L1	.1 µH ±10%	4300-7555	99800	1025, .1 µH ±10%	
RESISTORS					
R1	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R2	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R3	Comp. 910 Ω ±5% 1/4 W	6099-1915	75042	BTS, 910 Ω ±5%	
R4	Comp. 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R5	Comp. 910 Ω ±5% 1/4 W	6099-1915	75042	BTS, 910 Ω ±5%	
R6	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R7	Comp. 33 Ω ±5% 1/4 W	6099-0335	75042	BTS, 33 Ω ±5%	
R8	Comp. 330 Ω ±5% 1/4 W	6099-1335	75042	BTS, 330 Ω ±5%	5905-686-3369
R9	Comp. 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R10	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R11	Comp. 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	
R12	Comp. 27 Ω ±5% 1/4 W	6099-0295	75042	BTS, 27 Ω ±5%	
R13	Comp. 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R14	Comp. 1.3 kΩ ±5% 1/4 W	6099-2135	75042	BTS, 1.3 kΩ ±5%	5905-686-3119
R15	Comp. 68 Ω ±5% 1/4 W	6099-0685	75042	BTS, 68 Ω ±5%	
R18	Film, 50 Ω ±0.5% 1/4 W	6619-3300	75042	CEA-TO, 50 Ω ±.5%	
R19	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R20	Comp. 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-279-4629
R21	Pot. Comp. 10 k ±20%	6040-0700	01121	FWC, 10 kΩ ±20%	5905-549-2773
R22	Comp. 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R23	Comp. 100 kΩ ±5% 1/4 Ws	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R24	Comp. 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129
R25	Comp. 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R26	Comp. 36 kΩ ±5% 1/4 W	6099-3365	75042	BTS, 36 kΩ ±5%	5905-683-7726
R27	Comp. 2.4 kΩ ±5% 1/4 W	6099-2245	75042	BTS, 2.4 kΩ ±5%	5905-683-7724
R28	Comp. 39 kΩ ±5% 1/4 W	6099-3395	75042	BTS, 39 kΩ ±5%	5905-686-3358
R29	Pot. Comp. 25 kΩ ±20%	6040-0800	01121	FWC, 25 kΩ ±20%	5905-958-7950
R30	Comp. 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R31	Pot. Comp. 25 kΩ ±20%	6040-0800	01121	FWC, 25 kΩ ±20%	5905-958-7950
R32	Comp. 30 kΩ ±5% 1/4 W	6099-3305	75042	BTS, 30 kΩ ±5%	5905-803-2908
R33	Comp. 6.2 kΩ ±5% 1/4 W	6099-2625	75042	BTS, 6.2 kΩ ±5%	5905-682-4100
R34	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R35	Comp. 33 kΩ ±5% 1/4 W	6099-3335	75042	BTS, 33 kΩ ±5%	
R36	Comp. 100 Ω ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R37	Comp. 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R38	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R39	Comp. 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R40	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R41	Comp. 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6462
R42	Pot. Comp. 10 kΩ ±20%	6040-0700	01121	FWC, 10 kΩ ±20%	5905-549-2773
R43	Comp. 5.6 kΩ ±5% 1/4 W	6099-2565	75042	BTS, 5.6 kΩ ±5%	5905-691-0195
R44	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R45	Comp. 18 kΩ ±5% 1/4 W	6099-3185	75042	BTS, 18 kΩ ±5%	5905-687-0000
R46	Comp. 820 Ω ±5% 1/4 W	6099-1825	75042	BTS, 820 Ω ±5%	
R47	Comp. 24 Ω ±5% 1/4 W	6099-0245	75042	BTS, 24 Ω ±5%	
R48	Comp. 18 k ±5% 1/4 W	6099-3185	75042	BTS, 18 kΩ ±5%	5905-687-0000
R49	470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSISTORS					
Q1	Type 2N5160	8210-1199	04713	2N5160	
Q2	Type 2N3866	8210-1120	79089	2N3866	
Q3	Type 2N5109	8210-1198	79089	2N5109	
Q4	Type 2N5249	8210-1077	24454	2N3390	
Q5	Type 2N5249	8210-1077	24454	2N3390	
Q6	Type 2N3906	8210-1112	93916	2N3906	
Q7	Type 2N5249	8210-1077	24454	2N3390	
Q8	Type 2N5249	8210-1077	24454	2N3390	
Q9	Type 2N3906	8210-1112	93916	2N3906	
DIODES					
CR1	Type 1N994	6082-1017	24446	1N994	
CR2	Type 1N994	6082-1017	24446	1N994	
CR3	Type 1N645	6082-1016	24446	1N645	5961-944-8222

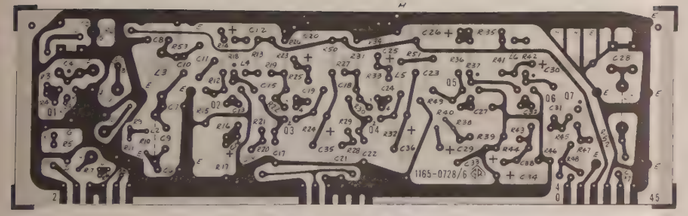


Figure 6-50. Mixer circuit etched-board assembly (P/N 1165-4028).

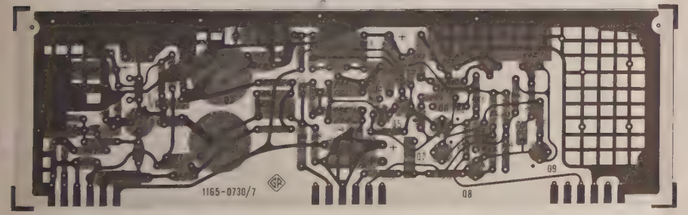


Figure 6-51. Amplifier circuit etched-board assembly (P/N 1165-4030).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

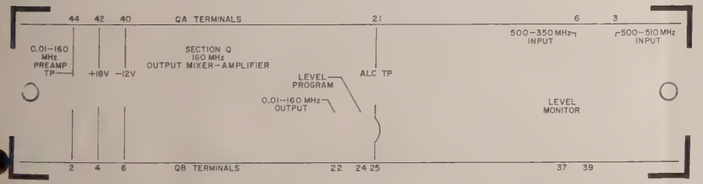
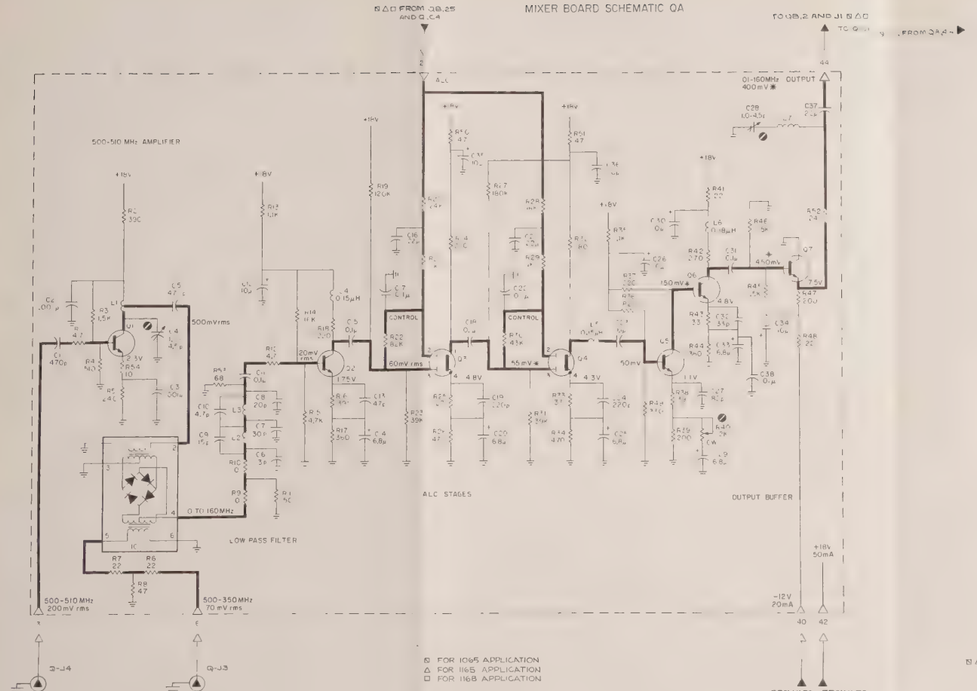


Figure 6-52. Bottom cover, exterior view, of section Q.



* rms VOLTAGES AT 1.0V rms INTO 50Ω OUTPUT FROM CB BOARD

NOTES: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD. ALL FEED THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF

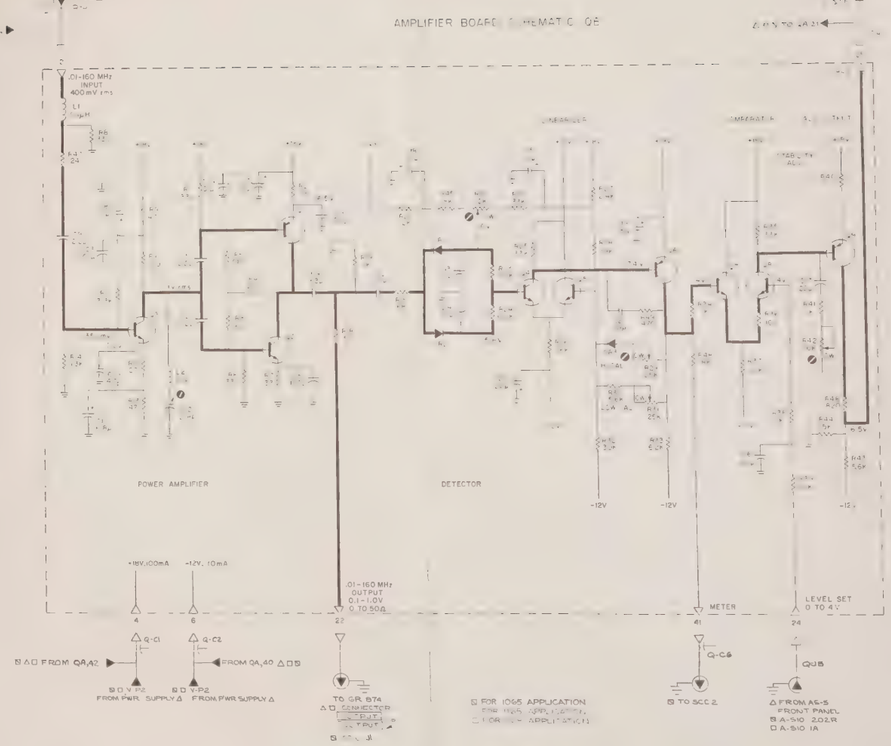


Figure 6-53. Section Q.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
	1065-4060 MIXER/DIVIDER BOARD (JC) IMD 5,01				
	CAPACITORS				
C1	Ceramic, 39 pF ±5%, 500 V	4411-3900	81131	CC01, 39 pF ±5%	5910-974-5697
C2	Ceramic, 121 pF ±1%, 500 V	4700-0661	14655	22A, 121 pF ±1%	
C3 and C4					
C5	Ceramic, 39 pF ±5%, 500 V	4411-3900	81131	CC01, 39 pF ±5%	5910-974-5697
C6	Trimmer, Ceramic, 5,5-18 pF	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
C7	Ceramic, 56 pF ±5% 100 V N080	4412-0565	72982	855, 56 pF ±5%	
C8	Ceramic Tubular, 2,7 pF ±10% 500 V	4400-0279	78488	GA, 2,7 pF ±10%	
C9	Ceramic, 56 pF ±5% 100 V N080	4412-0565	72982	855, 56 pF ±5%	
C10	Trimmer, Ceramic, 5,5-18 pF	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
C11	Ceramic, 6,2 pF ±5% 500 V N030	4411-9625	72982	0831003B1G00629J	
C12 and C13	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C14	Ceramic, 75 pF ±5% 100 V N150	4413-1002	72982	855, 75 pF ±5%	
C15	Ceramic Tubular, 1 pF ±10% 500 V	4400-0100	78488	GA, 1 pF ±10%	5910-034-5367
C16	Ceramic, 75 pF ±5% 100 V N150	4413-1002	72982	855, 75 pF ±5%	
C17 and C18	Ceramic, 47 pF ±5% 500 V	4404-0475	72982	831, 47 pF ±5%	
C19	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C20	Ceramic, 27 pF ±5% 100 V N030	4411-2007	72982	831, 27 pF ±5%	
C21	Trimmer, Ceramic 5,5-18 pF	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
C22	Ceramic Tubular, 1 pF ±10% 500 V	4400-0100	78488	GA, 1 pF ±10%	5910-034-5367
C23	Ceramic, 62 pF ±5% 100 V N150	4413-1001	72982	855, 62 pF ±5%	
C24	Ceramic, 6,8 pF ±5% 500 V N030	4411-9685	72982	0831003B1G00689J	
C25	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C26	Tant., 3,3 µF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
C27	Ceramic, .01 µF +80-20% 100 V	4401-3100	80131	CC61, .01 µF +80-20%	5910-974-5697
C28	Tant., 3,3 µF ±20% 15 V	4450-4600	56289	150D335X0015A2	5910-837-9325
C29	Mica, 1200 pF ±5% 500 V	4700-0685	14655	22A, 1200 pF ±5%	
C30	Mica, 162 pF ±1% 500 V	4710-0162	14655	22A, 162 pF ±1%	
C31	Trimmer, Ceramic, 5,5-18 pF	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
	CHOKES				
L1	9,1 µH ±2%	4300-7532	71895	BR511-44	
L2 and L3	Molded, 1,5 µH ±10%	4300-1000	99800	1537, 1,5 µH ±10%	
	INDUCTORS				
L4 and L5	Asm (RD)	1165-2410	24655	1165-2410	
L6	Asm (BK)	1165-2470	24655	1165-2470	
L7	Asm (VT)	1165-2470	24655	1165-2415	
	INTEGRATED CIRCUITS				
U1	Digital	5431-9610	04713	MC, 10131	
U2	Digital	5431-9609	04713	MC, 0913L	
	RESISTORS				
R1	Comp., 18 kΩ ±5% 1/4 W	6099-3185	75042	BTS, 18 kΩ ±5%	5905-687-0000
R2	Comp., 1,5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1,5 kΩ ±5%	
R3	Comp., 360 Ω ±5% 1/4 W	6099-1365	75042	BTS, 360 Ω ±5%	
R4	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R5	Comp., 2,2 kΩ ±5% 1/4 W	6099-2225	75042	BTS, 2,2 kΩ ±5%	5905-723-5251
R6	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R7	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R8	Comp., 910 Ω ±5% 1/4 W	6099-1915	75042	BTS, 910 Ω ±5%	
R9	Comp., 240 Ω ±5% 1/4 W	6099-1245	75042	BTS, 240 Ω ±5%	
R10	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R11 and R12	Comp., 6,8 kΩ ±5% 1/4 W	6099-2685	75042	BTS, 6,8 kΩ ±5%	5905-686-9997
R13	Comp., 240 Ω ±5% 1/4 W	6099-1245	75042	BTS, 240 Ω ±5%	
R14	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R15	Comp., 2,7 kΩ ±5% 1/4 W	6099-2275	75042	BTS, 2,7 kΩ ±5%	
R16	Comp., 18 Ω ±5% 1/4 W	6099-0185	75042	BTS, 18 Ω ±5%	
R17	Comp., 1,8 kΩ ±5% 1/4 W	6099-2185	75042	BTS, 1,8 kΩ ±5%	5905-688-3738
R18	Comp., 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
	TRANSFORMERS				
T1		1160-2610	24655	1160-2610	
T2		1160-2613	24655	1160-2613	
T3		1160-2611	24655	1160-2611	
	INDUCTORS				
L1	Choke, molded 12 µH	4300-7525	71895	153-, 12 µH	
L2	Choke, molded	1165-2405	24655	1165-2405	
L3	Choke, molded	1165-2410	24655	1165-2410	
L4	Choke, molded	1165-2415	24655	1165-2415	
L5	Choke, molded	1165-2411	24655	1165-2411	
L6	Choke, molded	1165-2470	24655	1165-2470	
L7	Choke, molded	1165-2415	24655	1165-2415	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
	RESISTORS (cont)				
R19	Comp., 39 [illegible] 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R21	Comp., 15 [illegible] 1/4 W	6099-1155	75042	BTS, 15 Ω ±5%	
R22	Comp., 47 [illegible] 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	
R23	Comp., 2,2 [illegible] 1/4 W	6099-2225	75042	BTS, 2,2 kΩ ±5%	5905-723-5251
R24	Comp., 680 [illegible] 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R25	Comp., 1,5 [illegible] 1/4 W	6099-2155	75042	BTS, 1,5 kΩ ±5%	
	SOCKETS				
XU1 and XU2	IC, 14 Cont PC	7540-1814	70763	141-001-111N	
	TRANSFORMERS				
T1		1160-2611	24655	1160-2611	
	TRANSISTORS				
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2 thru Q5	Type 2N3903	8210-1132	93916	2N3903	
Q6	Type 2N4275	8210-1126	23342	2N4275	

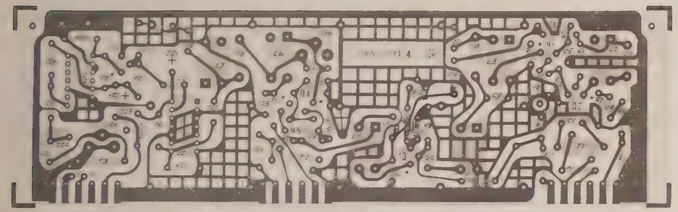


Figure 6-54. Mixer/divider circuit etched-board assembly (P/N 1065-4065).

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.

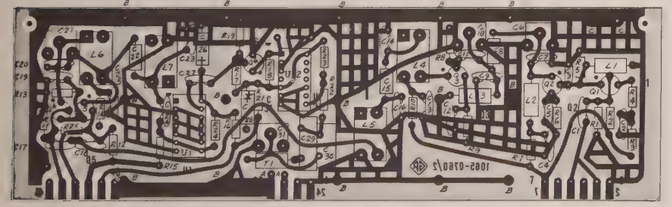


Figure 6-55. Divider circuit etched-board assembly (P/N 1065-4060).

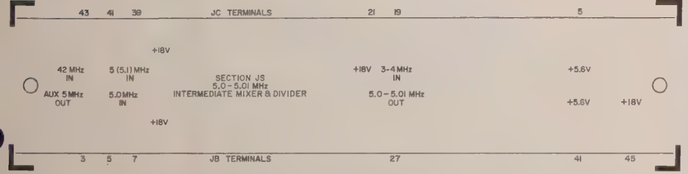
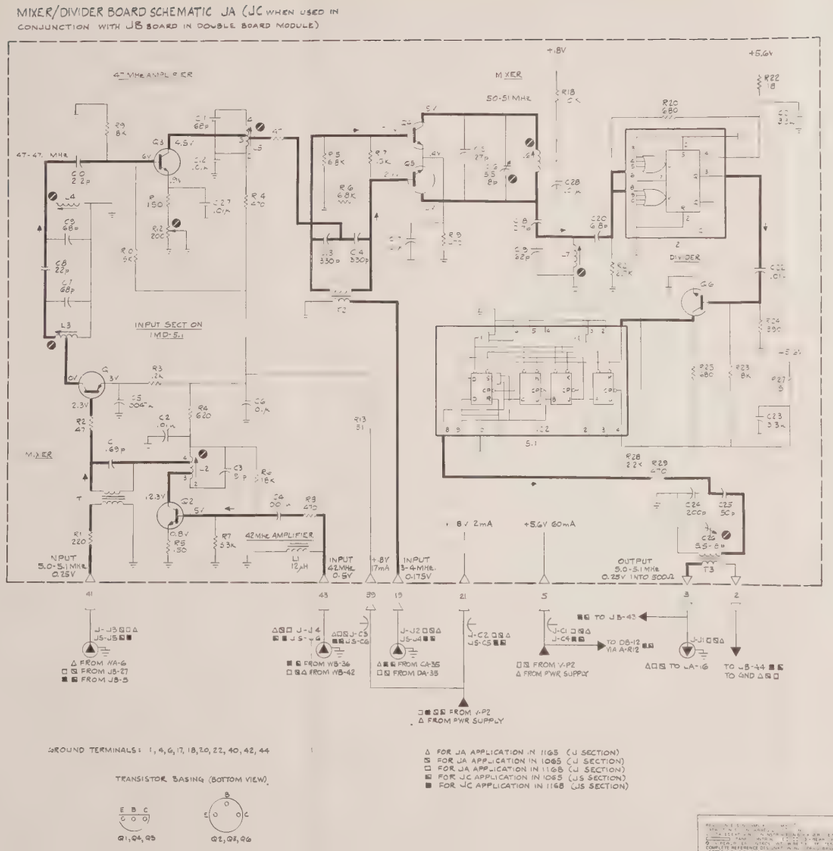


Figure 6-56. Bottom cover, exterior view, of section JS.


MIXER/DIVIDER BOARD SCHEMATIC JA (JC WHEN USED IN CONJUNCTION WITH J8 BOARD IN DOUBLE BOARD MODULE)
42 MHz AMPLIFIER
MIXER
50-51 MHz
DIVIDER
INPUT SECTION IMP-51
42 MHz AMPLIFIER
INPUT 5.0-5.1 MHz 0.25V
INPUT 42 MHz 0.5V
INPUT 3-4 MHz 0.175V
OUTPUT 5.0-5.1 MHz 0.25V INTO 200Ω
+8V 2mA
+5.6V 60mA
+8V 7mA
GROUND TERMINALS: 1, 4, 6, 17, 18, 20, 22, 40, 42, 44
TRANSISTOR BASING (BOTTOM VIEW)
Q1, Q4, Q5
Q2, Q3, Q6
△ FOR JA APPLICATION IN 1165 (J SECTION)
▨ FOR JA APPLICATION IN 1065 (J SECTION)
□ FOR JA APPLICATION IN 1165 (J SECTION)
■ FOR JC APPLICATION IN 1065 (J8 SECTION)
■ FOR JC APPLICATION IN 1165 (J8 SECTION)

DIVIDER BOARD SCHEMATIC J5
□ FOR C6S APPLICATION ONLY
▨ FOR J6B APPLICATION ONLY
TO J6S (VIA A11) FROM V-P2
NOTE: EACH TERMINAL NUMBER SHOWN AT THE EDGE OF THE CIRCUIT BLOCK IS IDENTICAL TO THE EXTERNAL TERMINAL NUMBERS MARKED ON THE BOTTOM COVER PLATE OF THE SECTION OF THE INSTRUMENT CONTAINING THE CIRCUIT BOARD
ALL FEED-THROUGH CAPACITORS ARE GROUNDED TO ENCLOSURE AND ARE 1000 pF
TRANSISTOR BASING (BOTTOM VIEW)
Q1, 2, 3, 4, 5

Figure 6-57. Section JS.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1065-4044 OSCILLATOR CIRCUIT ASM (DA) (DO-3-2)					
CAPACITORS					
C2	Elect., 150 µF +20% 20 V	4450-5723	90201	20000331100107	
C3	Tant., 15 µF +20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C4	Ceramic, 1000 pF ±5% 500 V	4405-2105	72982	801, 1000 pF ±5%	
C5	Mylar, .1 µF ±5% 100 V	4860-8254	84411	663UW, .1 µF ±5%	
C6	Mylar, .01 µF ±5% 100 V	4860-7755	84411	663UW, .01 µF ±5%	
C7	Mylar, .01 µF ±1% 100 V	4860-7752	84411	663UW, .01 µF ±1%	
C8	Mylar, .00280 µF ±1% 200 V	4860-7346	84411	663UW, .00280 µF ±1%	
C9	Tant., 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C10	Ceramic, 1000 pF ±5% 500 V	4405-2105	72982	801, 1000 pF	
C11	Ceramic, .01 µF +80-20% 100 V	4401-3100	20131	CC61, .01 µF +80-20%	5910-974-5697
C12	Mica, 330 µF ±5% 500 V	4700-0516	14655	22A, 330 µF ±2%	
C13	Trimmer, Ceramic 5.5-18 pF	4910-2031	72982	538-006, 5.5 to 18 pF NPO	
C14 and C15	Tant., 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C16	Ceramic .01 µF +80-20% 100 V	4401-3130	20131	CC61, .01 µF +80-20%	5910-974-5697
C17	Mylar, .022 µF ±10% 100 V	4860-7890	84411	663UW, .022 µF ±10%	5910-055-6119
C18	Ceramic, .01 µF +80-20% 100 V	4401-3130	20131	CC61, .01 µF +80-20%	5910-974-5697
C19	Mica, 169 µF ±2% 500 V	4700-0443	14655	22A, 169 µF ±2%	
C20 and C21	Ceramic, .01 µF +80-20% 100 V	4401-3100	20131	CC61, .01 µF +80-20%	5910-974-5697
CHOKES					
L1	Variable 17-18 H	4300-3790	79089	81218	
L2	Molded 18 µH ±10%	4300-2500	99800	1537-42, 18 µH ±10%	
DIODES					
CR1 and CR2	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR3 and CR4	Type 1N4442	6082-1009	24446	1N4442	5961-929-9967
CR5 and CR6	Type 1N3604	6082-1001	24446	1N3604	5961-995-2199
CR7 and CR8	Type 1N4442	6082-1009	24446	1N4442	5961-929-9967
INDUCTOR					
L3	Coil Wound	1452-1510	24655	1452-1510	
RESISTORS					
R1 and R2	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R3	Comp., 220 Ω ±5% 1/4 W	6099-1225	75042	BTS, 220 Ω ±5%	5905-683-2240
R4	Comp., 3.9 kΩ ±5% 1/4 W	6099-2395	75042	BTS, 3.9 kΩ ±5%	
R5	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R6	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R7	Comp., 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R8	Comp., 330 Ω ±5% 1/4 W	6099-1315	75042	BTS, 330 Ω ±5%	5905-686-3369
R10	Comp., 470 Ω ±5% 1/4 W	6099-1475	75042	BTS, 470 Ω ±5%	5905-683-2242
R11	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R13	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R14	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R15	Comp., 750 Ω ±5% 1/4 W	6099-1755	75042	BTS, 750 Ω ±5%	
R16	Comp., 10 Ω ±5% 1/4 W	6099-0103	75042	BTS, 10 Ω ±5%	5905-809-8596
R18	Comp., 200 Ω ±10% 1/4 W	6099-1205	75042	BTS, 200 Ω ±5%	5905-683-2239
R19	Comp., 680 Ω ±5% 1/4 W	6099-1685	75042	BTS, 680 Ω ±5%	
R20	Comp., 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ ±5%	
R21 and R22	Comp., 11.8 kΩ ±1% 1/4 W	6250-2118	75042	CEA, 11.8 kΩ ±1%	
R23	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R24	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R25	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R26	Comp., 390 Ω ±5% 1/4 W	6099-1395	75042	BTS, 390 Ω ±5%	
R27	Comp., 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R28 and R29	Comp., 11 kΩ ±5% 1/4 W	6099-3115	75042	BTS, 11 kΩ ±5%	
R30	Comp., 12 kΩ ±5% 1/4 W	6099-3125	75042	BTS, 12 kΩ ±5%	
R31	Comp., 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 4.7 kΩ ±5%	5905-686-9992
R32	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R33	Comp., 100 kΩ ±5% 1/4 W	6099-4105	75042	BTS, 100 kΩ ±5%	5905-686-3129

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No
1065-4044 OSCILLATOR CIRCUIT ASM (DA) (DO-3-2) (cont)					
RESISTORS (cont)					
R34	Comp., 39 kΩ ±5% 1/4 W	6099-3395	75042	BTS, 39 kΩ ±5%	5905-686-3358
R35	Comp., 15 kΩ ±5% 1/4 W	6099-3155	75042	BTS, 15 kΩ ±5%	5905-681-8818
R36	Comp., 10 kΩ ±5% 1/4 W	6099-3105	75042	BTS, 10 kΩ ±5%	5905-683-2238
R37	Comp., 3.9 MΩ ±5% 1/4 W	6099-5395	75042	BTS, 3.9 MΩ ±5%	
R38	Comp., 2 MΩ ±5% 1/4 W	6099-5205	75042	BTS, 2 MΩ ±5%	
R39	Comp., 560 Ω ±5% 1/4 W	6099-1565	75042	BTS, 560 Ω ±5%	
R40	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R41	Comp., 150 Ω ±5% 1/4 W	6099-1155	75042	BTS, 150 Ω ±5%	5905-683-2243
R43	Comp., 47 Ω ±5% 1/4 W	6099-0475	75042	BTS, 47 Ω ±5%	
R44	Comp., 20 kΩ ±5% 1/4 W	6099-3205	75042	BTS, 20 kΩ ±5%	5905-686-3368
R45	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R46	Comp., 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
SOCKETS					
XU13 and XU14	Transistor	7540-3450	91506	#8069-1G2	
TRANSFORMERS					
T1	Transformer Asm	5000-2121	24655	5000-2121	
TRANSISTORS					
Q1	Type 2N4123	8210-1123	04713	2N4123	
Q2	Type 2N3905	8210-1114	04713	2N3905	
Q3	Type 2N2218	8210-1028	96214	2N2218	5960-059-4464
Q4	Type 2N3903	8210-1132	04713	2N3903	
Q5	Type 2N3905	8210-1114	04713	2N3905	
Q6 thru Q8	Type 2N2218	8210-1028	96214	2N2218	5960-059-4464
Q9	Type DN-259	8210-1170	17856	DN-259	
Q10	Type 2N3903	8210-1132	04713	2N3903	
Q11 and Q12	Type 2N3905	8210-1114	04713	2N3905	
Q15	Type 2N3903	8210-1132	04713	2N3903	
Q16	Type 2N4123	8210-1123	04713	2N4123	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No	Fed Stock No
1065-4046 PROGRAM BOARD (DB) (DO-3-2)					
CAPACITORS					
C1	Tant., 330 µF ±20% 6 V	4450-5707	37942	TT, 330 µF ±20%	
C2	Mica, 464 pF ±20% 500 V	4710-0535	14655	22A, 464 pF ±1%	5910-052-6547
C3	Ceramic, 1000 pF ±5% 500 V	4405-2105	72982	801, 1000 pF ±5%	
DIODES					
CR1 thru CR5	Type 1N995	6082-1002	80368	1N995	5961-893-6762
CR12 thru CR16	Type 1N995	6082-1002	80368	1N995	5961-893-6762
CR17 and CR18	Type 1N995	6082-1002	80368	1N995	5961-893-6762
CR21 and CR22	Type 1N995	6082-1002	80368	1N995	5961-893-6762
INTEGRATED CIRCUITS					
U3	Digital	5431-8190	96214	SN7490N	
U4 and U5	Digital	5431-8100	96214	SN7400N	
U6	Digital	5431-8176	96214	SN7476N	
U9 and U10	Digital	5431-9604	18324	N8280A	
U12	Digital	5431-9362	96214	SN15816N	
U13	Digital	5431-9467	96214	SN15846N	
U14	Digital	5431-8210	96214	SN74H10N	
RESISTORS					
R1	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R2	Comp., 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-686-3370
R3 and R4	Comp., 1 kΩ ±5% 1/4 W	6099-2105	75042	BTS, 1 kΩ ±5%	5905-681-6422
R5	Comp., 2 kΩ ±5% 1/4 W	6099-2205	75042	BTS, 2 kΩ ±5%	5905-686-3370
R12 thru R17	Comp., 3.3 kΩ ±5% 1/8 W	6098-2335	01121	BB, 3.3 kΩ ±5%	
R18	Comp., 470 kΩ ±5% 1/4 W	6099-1475	75042	BTS, 470 kΩ ±5%	5905-683-2242
R19 and R20	Comp., 10 kΩ ±5% 1/8 W	6098-3105	01121	BB, 10 kΩ ±5%	
SOCKETS					
XU9 and XU10	Transistor	7540-1814	70763	141-001-111N	

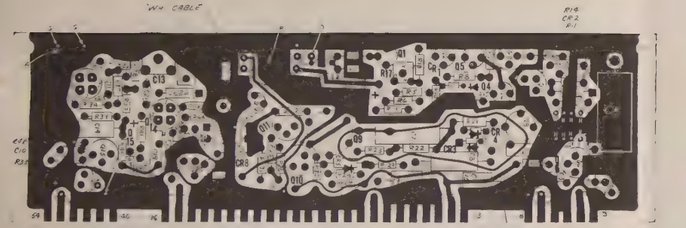


Figure 6-58. Oscillator circuit etched-board assembly (P/N 1065-4044).

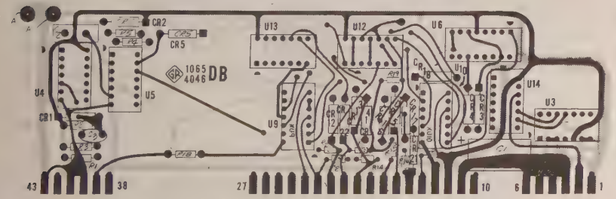


Figure 6-59. Program circuit etched-board assembly (P/N 1065-4046).

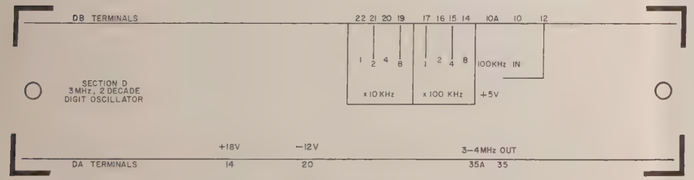
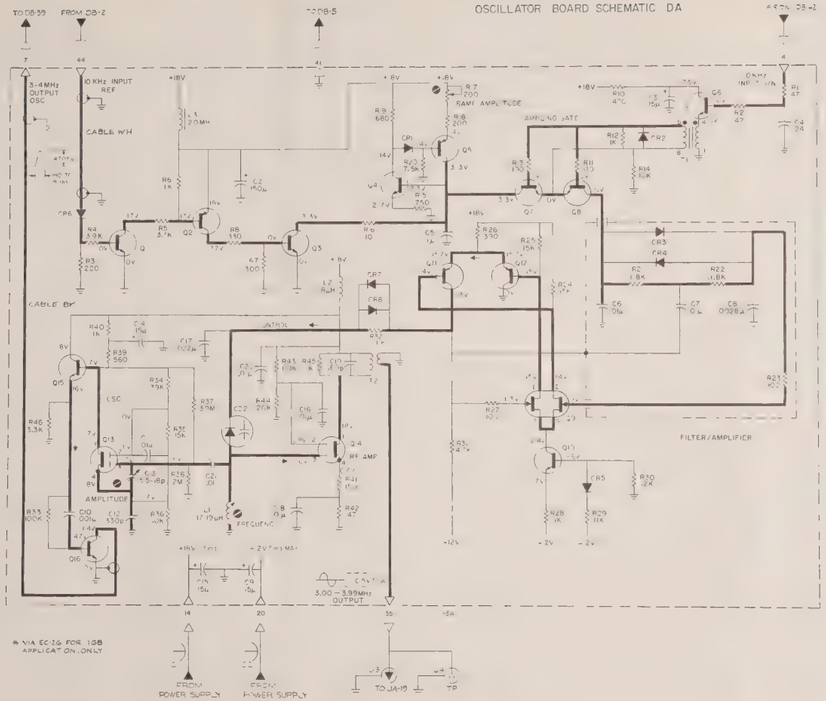


Figure 6-60. Bottom cover, exterior view, of section D.

NOTE: The board is shown foil-side up. The number appearing on the foil side is *not* the part number. The dot on the foil at the transistor socket indicates the collector lead.



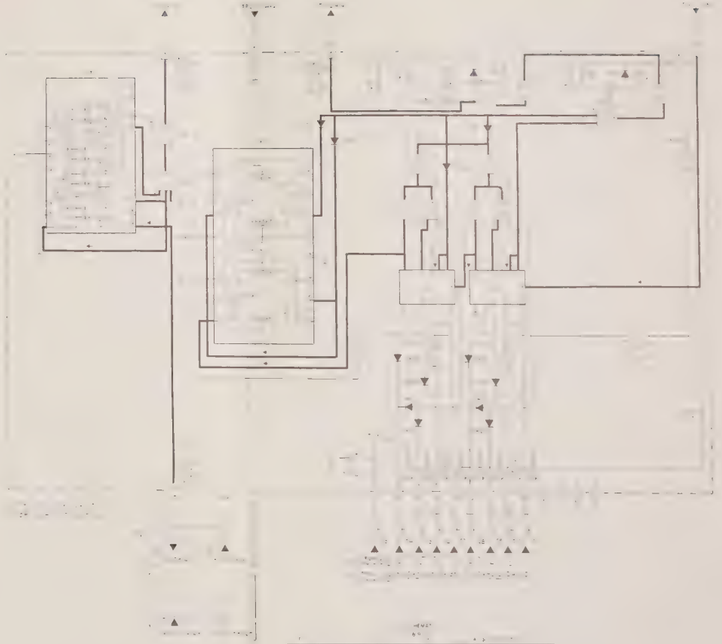


Figure 6-61. Section D.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4116 REAR-PANEL - POWER SUPPLY ASM (V)					
CAPACITORS					
C1	Electrolytic, 7500 µF +75-10% 20 V	4450-6222	80182	32D722G0115BA6B	
C2	Electrolytic, 4500 µF +75-10% 40 V	4450-6221	56289	32D442G040BAGB	
C3	Electrolytic, 3400 µF +75-10% 40 V	4450-4100	56289	32D, 3400 µF +75-10%	
C4-A thru -8	1000-1000 µF +100-10% 6 V	4450-2450	37942	FP-20-21992-99-3	
TRANSISTORS					
Q1	Type 4-250	8210-1095	12672	40250	
Q2 and Q3	Type 4-250	8210-1095	12672	40250	
Q4	Type 2-5655	8210-1047	12672	40251	
JACKS					
J1	Signal Jack	4240-0700	24655	4240-0701	5935-794-3012
J2	Signal Jack	4240-5220	95354	51-6020-1100	
J3 thru J5	Signal Jack	4260-1010	91616	SKT-8	
FUSES					
F1	Slo-Blo 7/10A	5330-1100	71400	MDL, 6 Amp	5920-280-3161
F2	Slo-Blo 1/10A	5330-0800	71400	MDL, 3 Amp	5920-235-8362
TRANSFORMER					
T1	Power	0485-4051	24655	0485-4051	
SWITCH					
S1	Slide	7910-0832	82389	11A-1118	
RESISTORS					
R1	Comp, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R2	Comp, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R3	Comp, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	5905-279-5481
R4	Comp, 300 Ω ±5% 1/4 W	6099-1305	75042	BTS, 300 Ω ±5%	
R5	Comp, 2.7 Ω ±5% 1/4 W	6099-9275	75042	BTS, 2.7 Ω ±5%	
SOCKETS					
XQ1	Transistor, power	7540-1440	22753	PTS-4	
XQ2	Transistor, power	7540-1440	22753	PTS-4	
XQ3	Transistor, power	7540-1440	22753	PTS-4	
XQ4	Transistor	7530-1900	71785	24324	5935-476-3275

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1168-4050 RECTIFIER BOARD VA					
DIODES					
CR1	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR2	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR3	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR4	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR5	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR6	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR7	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR8	Type 1N3253	6081-1001	79089	1N3253	5961-814-4251
CR9 thru CR12	Type 1N645	6082-1016	24446	1N645	5961-087-6047
CR13 thru CR16	Type 1N4140	6081-1014	24446	1N695	
RESISTOR					
R1	Low power wire wound 2.2 Ω ±10% 2 W	6760-9229	75042	BWH, 2.2 Ω ±10%	
R2	Comp., 4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω ±5%	
CAPACITORS					
C1	Tant., 120 µF ±20% 10 V	4450-5616	56289	150D127X0010R2	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1168-4055 REGULATOR BOARD (VB)					
CAPACITORS					
C1	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D465X0015B2	5910-813-8160
C2	Ceramic, .1 µF +20% 25 V	4400-2050	80183	SC13, .1 µF ±20%	5910-080-4646
C3	Electrolytic, 33 µF +50-10% 10 V	4450-5408	56289	150D336X0010B2	5910-853-0023
C4	Electrolytic, 4.7 µF ±20% 10 V	4450-4700	56289	150D465X0015B2	5910-813-8160
C5	Ceramic, .1 µF ±20% 25 V	4400-2050	80183	SC13, .1 µF ±20%	5910-974-5695
C6	Electrolytic, 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C7	Electrolytic, 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C8	Ceramic, .1 µF ±20% 25 V	4400-2050	80183	SC13, .1 µF ±20%	5910-974-5695
C9	Electrolytic, 47 µF ±20% 20 V	4450-5614	56289	150D476X0020R2	
C10	Electrolytic, 60 µF +150-10% 20 V	4450-2900	56289	D17872	
C11	Ceramic, .001 µF ±20% 500 V	4404-2100	72982	831, .001 µF ±20%	
DIODES					
CR1	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR2	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR3	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR4	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR5	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR6	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR7	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR8	Type 1N5297	6084-2000	04713	1N5297	
CR9	Type 1N191	6082-1008	93916	1N191	5961-296-3360
CR10	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
RESISTORS					
R1	Comp, 4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω ±5%	
R2	Film, 1.40 kΩ ±1% 1/8 W	6250-1140	75042	CEA, 1.40 kΩ ±1%	
R3	Pot. Comp, 100 Ω	6049-0103	73138	62PR100	
R4	Film 3.09 kΩ ±1% 1/8 W	6250-1309	75042	CEA, 3.09 kΩ ±1%	
R5	Comp. 10 kΩ ±10% 1/8 W	6098-3109	01121	BB, 10 kΩ ±5%	
R6	Comp. 51 Ω ±5% 1/8 W	6098-0515	01121	BB, 51 Ω ±5%	
R7	Comp. 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R8	Comp. 4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω ±5%	
R9	Comp. 3.3 kΩ ±5% 1/4 W	6099-2335	75042	BTS, 3.3 kΩ ±5%	5905-681-9969
R10	Low Power wire wound .82 Ω ±5% 2 W	6760-8825	75042	BWH, .82 Ω ±5%	
R11	Comp. 360 Ω ±5% 1/4 W	6099-1365	75042	BTS, 360 Ω ±5%	
R12	Comp. 2.7 Ω ±5% 1/4 W	6099-9275	75042	BTS, 2.7 Ω ±5%	
R13	Comp. 4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω ±5%	
R14	Film, 8.66 kΩ ±1% 1/8 W	6250-1866	75042	CEA, 8.66 kΩ ±1%	5905-755-8130
R15	Pot. Comp, 1 k	6049-0106	98474	62PRIK	
R16	Film, 3.09 kΩ ±1% 1/8 W	6250-1309	75042	CEA, 3.09 kΩ ±1%	
R17	Low power wire wound 62 Ω ±5% 2 W	6760-8625	75042	BWH, .62 Ω ±5%	
R18	Film, 13.3 kΩ ±1% 1/8 W	6250-2133	75042	CEA, 13.3 kΩ ±1%	
R19	Pot. Comp, 500 Ω	6049-0105	98474	62TR500	
R20	Film, 8.45 kΩ ±1% 1/8 W	6250-1845	75042	CEA, 8.45 kΩ ±1%	5905-752-7397
R21	Comp, 12 kΩ ±5% 1/8 W	6098-3125	01121	BB, 12 kΩ ±5%	
R22	Comp, 51 Ω ±5% 1/8 W	6098-0515	01121	BB, 51 Ω ±5%	
R23	Comp, 12 kΩ ±5% 1/8 W	6098-3125	01121	BB, 12 kΩ ±5%	
R24	Comp, 20 kΩ ±5% 1/8 W	6098-3205	01121	BB, 20 kΩ ±5%	
R25	Low power wire wound .27 Ω ±5% 2 W	6760-8275	75042	BWH, .27 Ω ±5%	
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N3905	8210-1114	04713	2N3905	
Q3	Type 2N3905	8210-1114	04713	2N3905	
Q4	Type 2N3391A	8210-1092	24454	2N3391A	
Q5	Type 2N3391A	8210-1040	82219	2N697	5961-752-0150
Q6	Type 2N3391A	8210-1092	24454	2N3391A	
Q7	Type 2N3391A	8210-1092	24454	2N3391A	
Q8	Type 2N3391A	8210-1092	24454	2N3391A	
Q9	Type 2N3905	8210-1114	04713	2N3905	
Q10	Type 2N3391A	8210-1092	24454	2N3391A	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1165-4057 SHUNT REGULATOR BOARD (VC)					
CAPACITORS					
C1	Electrolytic, 330 µF ±20% 6 V	4450-5707	56289	150D187X0006R2	
C2	Electrolytic, 47 µF ±20% 20 V	4450-5500	56289	150D156X0020B2	5910-855-6335
C3	Electrolytic, 6500 µF +75-10% 40 V	4450-4600	56289	150D682X0040B2	5910-853-0023
C4	Electrolytic, 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
C5	Electrolytic, 15 µF ±20% 20 V	4450-5200	56289	150D156X0020B2	5910-855-6335
RESISTORS					
R1	Comp. 4.7 Ω ±5% 1/4 W	6099-9475	75042	BTS, 4.7 Ω ±5%	
R2	Comp. 100 Ω ±5% 1/4 W	6099-1105	75042	BTS, 100 Ω ±5%	
R3	Comp. 620 Ω ±5% 1/4 W	6099-1625	75042	BTS, 620 Ω ±5%	5905-801-6998
R4	Comp. 27 kΩ ±5% 1/4 W	6099-3275	75042	BTS, 27 kΩ ±5%	5905-683-3838
R5	Comp. 13 kΩ ±5% 1/4 W	6099-3135	75042	BTS, 13 kΩ ±5%	5905-702-4439
R6	Comp. 4.7 kΩ ±5% 1/4 W	6099-2475	75042	BTS, 47 kΩ ±5%	5905-686-9992
R7	Comp. 56 Ω ±5% 1/4 W	6099-1135	75042	BTS, 110 Ω ±5%	5905-686-9992
R8	Comp. 1.5 kΩ ±5% 1/4 W	6099-2155	75042	BTS, 1.5 kΩ ±5%	
R9	Comp. 1.2 kΩ ±5% 1/4 W	6099-2125	75042	BTS, 7.5 kΩ ±5%	
R10	Comp. 7.5 kΩ ±5% 1/4 W	6099-2755	75042	BTS, 7.5 kΩ ±5%	
TRANSISTORS					
Q1	Type 2N3905	8210-1114	04713	2N3905	
Q2	Type 2N3391A	8210-1092	24454	2N3391A	
Q3	Type 2N697	8210-1040	82219	2N697	5961-752-0150

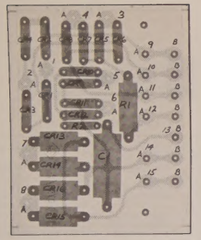


Figure 6-62. Rectifier circuit etched-board assembly (P/N 1168-4050).

Figure 6-63. Regulator circuit etched-board assembly (P/N 1168-4055).

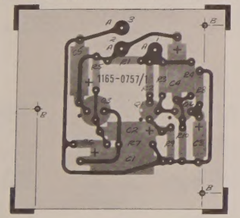
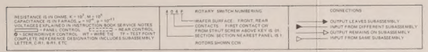


Figure 6-64. Shunt regulator circuit etched-board assembly (P/N 1165-4057).


ROTARY SWITCH NUMBERING
WAFER SURFACE - FRONT REAR
CONTACTS - FIRST CONTACT OF
SECTION, SECOND CONTACT OF SECTION, SECTION NEAREST PANEL IS 1
ROTORS SHOWN CCW
CONNECTIONS
OUTPUT LEAVES SUBASSEMBLY
INPUT FROM DIFFERENT SUBASSEMBLY
OUTPUT REMAINS ON SUBASSEMBLY
INPUT FROM SAME SUBASSEMBLY

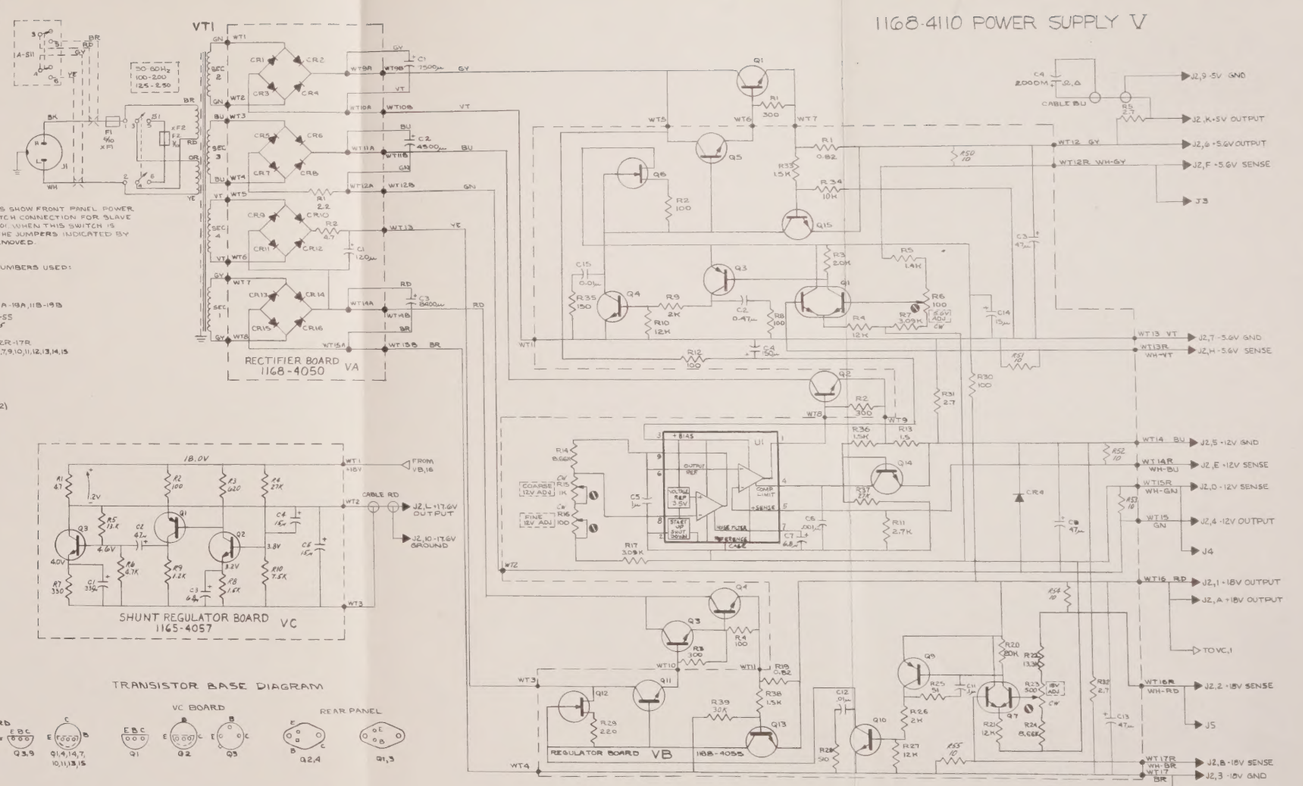


Figure 6-65. Rear panel and power supply schematic.

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1
(Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00192	Jones Mfg. Co, Chicago, Illinois
00194	Walsco Electronics Corp, L.A., Calif.
00434	Schweber Electronics, Westburg, L.I., N.Y.
00656	Aerovox Corp, New Bedford, Mass.
01009	Alden Products Co, Brockton, Mass.
01121	Allen-Bradley, Co, Milwaukee, Wisc.
01236	Leeds Radio Company, N.Y.
01255	Litton Industries Inc, Beverly Hills, Calif.
01295	Texas Instruments, Inc, Dallas, Texas
02114	Ferrocxube Corp, Saugerties, N.Y. 12477
02606	Fenwal Lab Inc, Morton Grove, Ill.
02660	Amphenol Electron Corp, Broadview, Ill.
02768	Fastex, Des Plaines, Ill. 60016
03042	Carter Ink Co., Camb. Mass. 02142
03508	G.E. Semicon Prod, Syracuse, N.Y. 13201
03636	Graybarne, Yonkers, N.Y. 10701
03888	Pyrofilm Resistor Co, Cedar Knolls, N.J.
03911	Claires Corp, New York, N.Y. 10001
04009	Arrow-Hart & Hegeman, Hart., Conn. 06106
04643	Digitronix Corp., Albertson, N.Y. 11507
04713	Motorola, Phoenix, Ariz. 85008
05170	Engr'd Electronics, Santa Ana, Calif. 92702
05624	Barber-Colman Co, Rockford, Ill. 61101
05748	Barnes Mfg. Co., Mansfield, O. 44901
05820	Wakefield Eng, Inc, Wakefield, Mass. 01880
06743	Clevite Corp., Cleveland, O. 44110
07126	Digitron Co, Pasadena, Calif.
07127	Eagle Signal (E.W. Bliss Co.), Baraboo, Wisc.
07261	Avnet Corp, Culver City, Calif. 90230
07263	Fairchild Camera, Mountain View, Calif.
07387	Birtcher Corp, No. Los Angeles, Calif.
07595	Amer Semicond, Ashington Hts, Ill. 60004
07828	Bodine Corp, Bridgeport, Conn. 06605
07829	Bodine Electric Co, Chicago, Ill. 60618
07910	Cont Device Corp, Hawthorne, Calif.
07983	State Labs Inc, N.Y., N.Y. 10003
07999	Borg Inst., Delavan, Wisc. 53115
08730	Vemaline Prod Co., Franklin Lakes, N.J.
09213	G.E. Semiconductor, Buffalo, N.Y.
09408	Star-Tronics Inc, Georgetown, Mass. 01830
09823	Burgess Battery Co, Freeport, Ill.
09922	Burndy Corp, Norwalk, Conn. 06852
11236	C.T.S. of Berne, Inc, Berne, Ind. 46711
11599	Chandler Evans Corp, W. Hartford, Conn.
12040	National Semiconductor, Danbury, Conn.
12498	Crystalonics, Cambridge, Mass. 02140
12672	RCA, Woodbridge, N.J.
12697	Clarostat Mfg Co, Inc, Dover, N.H. 03820
12954	Dickson Electronics, Scottsdale, Ariz.
13327	Solitron Devices, Tappan, N.Y. 10983
14433	ITT Semiconductors, W. Palm Beach, Fla.
14655	Cornell-Dubilier Electric Co., Newark, N.J.
14674	Corning Glass Works, Corning, N.Y.
14936	General Instrument Corp, Hicksville, N.Y.
15116	Microdot Magnetics Inc, Los Angeles, Calif.
15238	ITT, Semiconductor Div, Lawrence, Mass.
15605	Cutler-Hammer Inc, Milwaukee, Wisc. 53233
16037	Spruce Pine Mica Co, Spruce Pine, N.C.
16636	Indiana General Corp, Oglesby, Ill. 61348
17771	Singer Co, Diehl Div, Somerville, N.J.
18736	Voltronics Corp, Hanover, N.J. 07936
19396	Illinois Tool Works, Pakton Div, Chicago, Ill.
19048	Computer Diode Corp, S. Fairfawn, N.J. 07410
19617	Cabiron Corp., Chicago, Ill. 60622
19644	LRC Electronics, Horseheads, N.Y.
19701	Electra Mfg Co, Independence, Kansas 67301
20754	KMC Semiconductor Corp., Long Valley, N.J. 07853
21335	Fafnir Bearing Co, New Briton, Conn.
22753	UID Electronics Corp, Hollywood, Fla.
23342	Avnet Electronics Corp, Franklin Park, Ill.
24446	G.E., Schenectady, N.Y. 12305
24454	G.E., Electronics Comp, Syracuse, N.Y.
24455	G.E. (Lamp Div.), Nela Park, Cleveland, Ohio
24655	General Radio Co, W. Concord, Mass. 01781
26806	American Zettler, Inc, Costa Mesa, Calif.
28520	Heyman Mfg Co, Kenilworth, N.J.
28959	Hoffman Electronics Corp, El Monte, Calif.
30646	Beckman Instruments Inc, Cedar Grove, N.J. 07009
30874	I.B.M., Armonk, New York
32001	Jensen Mfg. Co, Chicago, Ill. 60638
33173	G.E. Comp, Owensboro, Ky. 42301
34141	Koehler Mfg. Co, Inc., Marlboro, Mass. 01752
35929	Constanta Co, Mont. 19, Que.
37942	P.R. Mallory & Co Inc, Indianapolis, Ind.
38443	Marlin-Rockwell Corp, Jamestown, N.Y.
40931	Honeywell Inc, Minneapolis, Minn. 55408
42190	Muter Co, Chicago, Ill. 60638
42498	National Co, Inc, Melrose, Mass. 02176
43991	Norma-Hoffman, Stanford, Conn. 06904
49671	RCA, New York, N.Y. 10020
49956	Raytheon Mfg Co, Waltham, Mass. 02154
53021	Sangamo Electric Co, Springfield, Ill. 62705
54294	Shallcross Mfg Co, Selma, N.C.
54715	Shure Brothers, Inc, Evanston, Ill.
56289	Sprague Electric Co, N. Adams, Mass.
59730	Thomas and Betts Co, Elizabeth, N.J. 07207
59875	TRW Inc, (Accessories Div), Cleveland, Ohio
60299	Torrington Mfg Co., Torrington, Conn.
61637	Union Carbide Corp, New York, N.Y. 10017
61864	United-Carr Fastener Corp, Boston, Mass.
63060	Victoreen Instrument Co, Inc, Cleveland, O.
63743	Ward Leonard Electric Co, Mt. Vernon, N.Y.
65083	Westinghouse (Lamp Div), Bloomfield, N.J.
65092	Weston Instruments, Newark, N.J.
70485	Atlantic-India Rubber, Chicago, Ill. 60607
70563	Amperite Co., Union City, N.J. 07087
70903	Belden Mfg Co, Chicago, Ill. 60644
71126	Bronson, Homer D, Co, Beacon Falls, Conn.
71279	Cambridge Thermionic Corp, Camb. Mass. 02138
71294	Canfield, H.O. Co, Clifton Forge, Va. 24422
71400	Bussman (McGraw Edison), St. Louis, Mo.
71468	ITT Cannon Elec, L.A., Calif. 90031
71590	Centralab, Inc, Milwaukee, Wisc. 53212
71666	Continental Carbon Co, Inc, New York, N.Y.
71729	Crescent Box Corp, E. Phila, Penn. 19134
71707	Coto Coil Co Inc, Providence, R.I.
71744	Chicago Miniature Lamp Works, Chicago, Ill.
71785	Cinch Mfg Co, Chicago, Ill. 60624
71823	Darnell Corp, Ltd, Downey, Calif. 90241
72136	Electro Motive Mfg Co, Wilmington, Conn.
72259	Nytronics Inc, Berkeley Heights, N.J. 07922
72619	Dialight Co, Brooklyn, N.Y. 11237
72699	General Instr Corp, Newark, N.J. 07104
72765	Drake Mfg Co, Chicago, Ill. 60656
72825	Hugh H. Eby Inc, Philadelphia, Penn. 19144
72962	Elastic Stop Nut Corp, Union, N.J. 07083
72982	Erie Technological Products Inc, Erie, Penn.
73138	Beckman Inc, Fullerton, Calif. 92634
73445	Amperex Electronics Co, Hicksville, N.Y.
73559	Carling Electric Inc, Hartford, Conn.
73690	Elco Resistor Co, New York, N.Y.
73899	JFD Electronics Corp, Brooklyn, N.Y. 11219
74193	Heinemann Electric Co, Trenton, N.J.
74861	Industrial Condenser Corp, Chicago, Ill. 60618
74868	Amphenol Corp, Danbury, Conn. 06810
74970	E.F. Johnson Co, Waseca, Minn. 56093
75042	IRC Inc, Philadelphia, Penn. 19108
75382	Kulka Electric Corp, Mt. Vernon, N.Y.
75491	Lafayette Industrial Electronics, Jamaica, N.Y.
75608	Linden and Co, Providence, R.I.
75915	Littelfuse, Inc, Des Plaines, Ill. 60016
76005	Lord Mfg Co, Erie, Penn. 16512
76149	Mallory Electric Corp, Detroit, Mich. 48204
76487	James Millen Mfg. Co., Malden, Mass. 02148
76545	Mueller Electric Co., Cleveland, Ohio 44114
76684	National Tube Co, Pittsburg, Penn.
76854	Oak Mfg Co, Crystal Lake, Ill.
77147	Patton MacGyver Co, Providence, R.I.
77166	Pass-Seymour, Syracuse, N.Y.
77263	Pierce Roberts Rubber Co, Trenton, N.J.
77330	Positive Lockwasher Co, Newark, N.J.
77342	American Machine & Foundry Co, Princton, Ind. 47570
77542	Ray-O-Vac Co, Madison, Wisc.
77630	TRW, Electronic Comp, Camden, N.J. 08103
77638	General Instruments Corp, Brooklyn, N.Y.
78189	Shakeproof (Ill. Tools Works), Elgin, Ill. 60120
78277	Sigma Instruments Inc, S. Braintree, Mass.
78488	Stackpole Carbon Co, St. Marys, Penn.
78553	Tinnerman Products, Inc, Cleveland, Ohio
79089	RCA, Rec Tube & Semicond, Harrison, N.J.
79725	Wiremold Co, Hartford, Conn. 06110
79963	Zierick Mfg Co, New Rochelle, N.Y.
80009	Tektronix Inc, Beaverton, Ore. 97005
80030	Prestole Fastener, Toledo, Ohio
80048	Vickers Inc, St. Louis, Mo.
80131	Electronic Industries Assoc, Washington, D.C.
80183	Sprague Products Co, No. Adams, Mass.
80211	Motorola Inc., Franklin Park, Ill. 60131
80258	Standard Oil Co, Lafeyette, Ind.
80294	Bourns Inc, Riverside, Calif. 92506
80368	Sylvania Electric Products Inc, N.Y. 10017
80431	Air Filter Corp, Milwaukee, Wisc. 53218
80583	Hammerlund Co, Inc, New York, N.Y.
80740	Beckman Instruments, Inc, Fullerton, Calif.
80894	Pure Carbon Co., St. Marys, Penn. 15857
81030	International Instrument, Orange, Conn.
81073	Grayhill Inc, LaGrange, Ill. 60525
81143	Isotemite Mfg Corp, Stirling, N.J. 07980
81349	Military Specifications
81350	Joint Army-Navy Specifications
81395	Fenwal Electronics, Framingham, Mass. 01701
81483	International Rectifier Corp, El Segundo, Calif. 90245
81751	Columbus Electronics Corp, Yonkers, N.Y.
81831	Filtron Co, Flushing, L.I., N.Y. 11354
81840	Ledex Inc, Dayton, Ohio 45402
81860	Berry-Wright Corp, Watertown, Mass.
82219	Sylvania Elec Prod, Emporium, Penn.
82273	Indiana Pattern & Model Works, LaPort, Ind.
82389	Switchcraft Inc, Chicago, Ill. 60630
82647	Metals & Controls Inc, Attleboro, Mass.
82807	Milwaukee Resistor Co, Milwaukee, Wisc.
82877	Rotron Mfg. Co. Inc., Woodstock, N.Y. 12498
83033	Meissner Mfg. (Maguire Ind) Mt. Carmel, Ill.
83058	Carr Fastener Co, Cambridge, Mass.
83186	Victory Engineering, Springfield, N.J. 07081
83361	Bearing Specialty Co, San Francisco, Calif.
83587	Solar Electric Corp, Warren, Penn.
83740	Union Carbide Corp, New York, N.Y. 10017
83781	National Electronics Inc, Geneva, Ill.
84411	TRW Capacitor Div, Ogallala, Nebr.
84535	Lehigh Metal Prods, Cambridge, Mass. 02140
84971	TA Mfg Corp, Los Angeles, Calif.
85073	Precision Metal Prods, Stoneham, Mass. 02180
86684	RCA (Elect. Comp & Devi), Harrison, N.J.
86687	REC Corp, New Rochelle, N.Y. 10801
86800	Cont Electronid Corp, Brooklyn, N.Y. 11222
88140	Cutler-Hammer Inc, Lincoln, Ill.
88219	Gould Nat. Batteries Inc, Trenton, N.J.
88419	Cornell-Dubilier, Fuquay-Varina, N.C.
88627	K & G Mfg Co, New York, N.Y.
89482	Holtzer-Cabot Corp, Boston, Mass.
89665	United Transformer Co, Chicago, Ill.
90201	Mallory Capacitor Co, Indianapolis, Ind.
90634	Gulton Industries, Inc, Metuchen, N.J. 08840
90750	Westinghouse Electric Corp, Boston, Mass.
90952	Hardware Products Co, Reading, Penn. 19602
91032	Continental Wire Corp, York, Penn. 17405
91146	ITT (Cannon Electric), Salem, Mass.
91210	Gerber Mfg. Co, Mishawaka, Ind.
91293	Johanson Mfg Co, Boonton, N.J. 07005
91506	Augat Inc, Attleboro, Mass. 02703
91588	Chandler Co, Wethersfield, Conn. 06109
91637	Dale Electronics Inc, Columbus, Nebr.
91662	Elco Corp, Willow Grove, Penn.
91719	General Instruments, Inc, Dallas, Texas
91916	Mephisto Tool Co. Inc, Hudson, N.Y. 12534
91929	Honeywell Inc, Freeport, Ill.
92519	Electra Insul Corp, Woodside, L.I., N.Y.
92676	E.G.&G., Boston, Mass.
92739	Ampex Corp, Redwood City, Calif. 94063
93332	Sylvania Elec Prods, Inc, Woburn, Mass.
93618	R. & C. Mfg. Co. of Penn. Inc., Ramey, Penn.
93916	Cramer Products Co, New York, N.Y. 10013
94144	Raytheon Co, Components Div, Quincy, Mass.
94154	Tung Sol Electric Inc, Newark, N.J.
94271	Weston Instruments Inc, Archbald, Penn. 18403
94589	Dickson Co., Chicago, Ill. 60619
94599	Elco Industrial Corp., Brooklyn, N.H.
95076	Garde Mfg. Co., Cumberland, R.I.
95121	Quality Components Inc, St. Mary's, Penn.
95146	Alco Electronics Mfg Co., Lawrence, Mass.
95238	Continental Connector Corp, Woodside, N.Y.
95275	Vitramon, Inc, Bridgeport, Conn.
95354	Methode Mfg Co, Chicago, Ill.
95412	General Electric Co, Schenectady, N.Y.
95794	Anaconda Amer Brass Co, Torrington, Conn.
96095	Hi-Q Div. of Aerovox Corp, Orlean, N.Y.
96214	Texas Instruments Inc, Dallas, Texas 75209
96256	Thordarson-Meissner, Mt. Carmel, Ill.
96341	Microwave Associates Inc, Burlington, Mass.
96791	Amphenol Corp, Janesville, Wisc. 53545
96906	Military Standards
97684	Models Inc, North Bergen, N.J.
98291	Sealectro Corp, Mamaroneck, N.Y. 10544
98974	Compar Inc, Burlingame, Calif.
98821	North Hills Electronics Inc., Glen Cove, N.Y.
99112	Metavac Inc, Flushing, N.Y. 11358
99180	Transitron Electronics Corp, Melrose, Mass.
99313	Varian, Palo Alto, Calif. 94303
99378	Attee Corp, Winchester, Mass. 01890
99800	Delevan Electronics Corp, E. Aurora, N.Y.

General Radio

*Concord, Massachusetts 01742
617 369-4400

SALES AND SERVICE

ALBUQUERQUE	505 265-1097	DETROIT	800 621-8105	*NEW YORK (NY)	212 964-2722
ANCHORAGE	907 279-5741	ERIE	† ZENITH 2203	(NJ)	201 943-3140
ATLANTA	800 638-0833	GREENSBORO	800 638-0833	PHILADELPHIA	215 646-8030
BOLTON	617 779-5562	GROTON	203 445-6445	PITTSBURGH	† ZENITH 2203
BOSTON	617 646-0550	HARTFORD	203 658-2496	ROCHESTER	315 454-9323
BURBANK	714 540-9830	HOUSTON	713 464-5112	SAN DIEGO	714 540-9830
*CHICAGO	312 992-0800	HUNTSVILLE	800 638-0833	*SAN FRANCISCO	415 948-8233
CLEVELAND	800 621-8105	INDIANAPOLIS	800 621-8105	SEATTLE	206 747-9190
COCOA BEACH	800 638-0833	LONG ISLAND	212 964-2722	SYRACUSE	315 454-9323
*DALLAS	214 637-2240	*LOS ANGELES	714 540-9830	*WASHINGTON,	
DAYTON	800 621-8105			BALTIMORE	301 881-5333

† Via operator

INTERNATIONAL DIVISION CONCORD, MASSACHUSETTS 01742, USA

*ARGENTINE and PARAGUAY
Cosain S.A.
Buenos Aires, Tel. 52-3185

*AUSTRALIA
Warburton Franki Industries Pty. Ltd.
Sydney, Tel. 29 1111
Melbourne, Tel. 69 0151
Brisbane, Tel. 51 5121
Adelaide, Tel. 56 7333

*BRAZIL
Ambriex S.A.
Rio de Janeiro, Tel. 242-7990
São Paulo, Tel. 52-7806

*CANADA
General Radio Canada Limited
Toronto, Tel. (416) 252-3395
Montreal, Ottawa

CHILE
Cosain Chile Ltda.
Santiago, Tel. 39-6713

COLOMBIA
Manuel Trujillo
Venegas e Hijo, Ltda.
Bogota 2, D. E., Tel. 320679

ECUADOR
Suministros Tecnicos Ltda.
Guayaquil, Tel. 512-419

HONG KONG and MACAU
Gilman & Co., Ltd.
Hong Kong, B.C.C., Tel. 227011

INDIA
Hindhave Private Limited
Bombay, Tel. 252337, Calcutta,
Lucknow, Kanpur, New Delhi,
Bangalore, Madras

*JAPAN
Motorrya Electric Co., Ltd.
Tokyo, Tel. 561-8851

KOREA
M-C International
San Francisco, Tel. (415) 397-1455
Seoul, Tel. 22-6891

MALAYSIA
Vanguard Company
Kuala Lumpur, Tel. 88213

*MEXICO
Electronica Fradin, S. A.
Mexico, 10 D. F., Tel. 20-89-48

NEW ZEALAND
W. & W. McLean Limited
Auckland, Tel. 587-039
Wellington, Tel. 555-869

PAKISTAN
Pak Land Corporation
Karachi, Tel. 472315

PERU
Importaciones y Representaciónes Electronicas S. A.
Lima, Tel. 272076

PHILIPPINES
T. J. Wolff & Company
Makati, Rizal, Tel. 89-34-86

SINGAPORE
Vanguard Company
Singapore, Tel. 94695

TAIWAN
Heighten Trading Co., Ltd.
Taipei, Tel. 518324

THAILAND
G. Simon Radio Co., Ltd.
Bangkok, Tel. 300911-2

URUGUAY
Cosain Uruguaya S.A.
Montevideo, Tel. 9 79 78

VENEZUELA
Cosain C. A.
Caracas, Tel. 72 96 37

*Repair services are available at these offices.

*GENERAL RADIO COMPANY (OVERSEAS)

P.O. Box 124, CH-8034, Zürich, Switzerland, Tel. 47 70 20

AUSTRIA
Dipl. Ing. Peter Marchetti
Wien, Tel. 57 82 30

BELGIUM
Groenpol Belgique S. A.
Bruxelles, Tel. 02/25 16 36

DEMOCRATIC REPUBLIC OF THE CONGO
Desco de Schutthess
Zürich, Tel. 25 44 50

DENMARK
SEMCO A/S
Glostrup, Tel. 45 21 22

EASTERN EUROPE
General Radio Company (Overseas)
Tel. 47 70 20

EIRE
General Radio Company (Overseas), Tel. 47 70 20
General Radio Company (U.K.) Limited, Tel. 22567

FINLAND
Into O/Y
Helsinki, Tel. 11 123

*FRANCE
General Radio France
Paris, Tel. 023 5774, Lyon

*GERMANY
General Radio GmbH
München, Tel. 40 18 17
Hamburg, Tel. 45 06 56

GREECE
Marios Dallegiogo
Representations
Athens, Tel. 710 669

IRAN
Berkeh Co. Ltd.
Tehran, Tel. 62 82 94

ISRAEL
Eastronics Ltd.
Tel Aviv, Tel. 44 04 66

*ITALY
General Radio Italia S.p.A.
Milano, Tel. 29 31 29

LEBANON
Projects
Beirut, Tel. 241200

NETHERLANDS
Groenpol Industriele
Verkoop N. V.
Amsterdam, Tel. 020/64/474

NORWAY
Gustav A. Ring A/S
Oslo, Tel. 46 68 90

PORTUGAL
Casa Serras
Lisboa

REPUBLIC OF SOUTH AFRICA
Associated Electronics (Pty.) Ltd.
Johannesburg, Tel. 724-5396

SPAIN
Hispano Electronica S. A.
Madrid, Tel. 233.16.01

SWEDEN
Firma Johan Lagercrantz KB
Solna, Tel. 08/83 07 90

SWITZERLAND
Swyffer & Co. A. G.
Zürich, Tel. 25 54 11

*UNITED KINGDOM
General Radio Company (U.K.) Limited
Bourne End, Buckinghamshire
Tel. 22 567

YUGOSLAVIA
General Radio Company (Overseas)
Tel. 47 70 20

PRINTED IN U.S.A.

GENERAL RADIO

WEST CONCORD, MASSACHUSETTS 01781

www.manualsplus.com

1022609